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National Register of Historic Places Multiple Property Documentation Form

This form is used for documenting property groups relating to one or several historic contexts. See instructions in National Register Bulletin *How to Complete the Multiple Property Documentation Form* (formerly 16B). Complete each item by entering the requested information. For additional space, use continuation sheets (Form 10-900-a). Use a typewriter, word processor, or computer to complete all items



New Submission Amended Submission

A. Name of Multiple Property Listing

Going with the Flow: Waterworks in Puerto Rico, 1840-1898

B. Associated Historic Contexts

(Name each associated historic context, identifying theme, geographical area, and chronological period for each.)

C. Form Prepared by

name/title Juan Llanes Santos / Historian
organization Puerto Rico State Historic Preservation Office date October 20, 2016
street & number PO Box 9023935 telephone 787-721-3737
city or town San Juan state PR zip code 00902-3935
e-mail jllanes@prshpo.pr.gov

D. Certification

As the designated authority under the National Historic Preservation Act of 1966, as amended, I hereby certify that this documentation form meets the National Register documentation standards and sets forth requirements for the listing of related properties consistent with the National Register criteria. This submission meets the procedural and professional requirements set forth in 36 CFR 60 and the Secretary of the Interior's Standards and Guidelines for Archeology and Historic Preservation.
(See continuation sheet for additional comments.)

Cariangeli Leon Moraza
Cariangeli Leon Moraza, Esq. PRSHPO
Signature and title of certifying official

10/24/2016
Date

Puerto Rico State Historic Preservation Office
State or Federal Agency or Tribal government

I hereby certify that this multiple property documentation form has been approved by the National Register as a basis for evaluating related properties for listing in the National Register.

Jane Sullivan
Signature of the Keeper

12.13.2016
Date of Action

**United States Department of the Interior
National Park Service**

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Provide the following information on continuation sheets. Cite the letter and title before each section of the narrative. Assign page numbers according to the instructions for continuation sheets in National Register Bulletin *How to Complete the Multiple Property Documentation Form* (formerly 16B). Fill in page numbers for each section in the space below.

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Going with the Flow: Waterworks in Puerto Rico,
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E. Going with the Flow: Waterworks in Puerto Rico, 1840-1898

I. Introduction

From the very early start, the pattern of human settlements in Puerto Rico have been determined by the availability of fresh water. The most significant archeological findings had showed that our pre-Columbian occupants organized their life around fresh water bodies. The material conditions of their existence reflected upon their ideological representations. The religious beliefs of the native population who met the first Europeans, later denominated as “*Táinos*”, gravitated around two supreme deities deeply associated with water as a source of life: Yucahu, the lord of the sea and cassava, and Atabey, his mother, who was the goddess of fresh water and human fertility.¹

During the early Spanish settlements in the island, the new European inhabitants equally located their homes in close proximity to the rivers or other bodies of fresh water like streams and spring waters. The success of the settlements, or its failure, depended in many occasions in the availability and quality of the precious liquid. Actually, the failure of the very first European settlement in Puerto Rico (Caparra), was described in the early chronicles as been caused in great part by the absence of good quality drinkable water. Our early chronicler, Gonzalo Fernández de Oviedo, described Caparra’s problem when he said “*Mas este pueblo, por la indisposición del asiento, fue mal sano y trabajoso, porque estaba entre montes y ciénagas, y las aguas eran acejosas, y no se criaban los niños*”.² The resource was not only indispensable for sustaining life, but also essential in many other daily activities: basic hygiene, cooking, washing, animal drinking water, and of course, agriculture.

¹ Irving Rouse, *The Tainos. Rise and Decline of the People Who Greeted Columbus*. Yale University Press, 1992, 13.

² “The disposition of this settlement was unhealthy and arduous, because it was in between forests and swamps, and the waters were uncleaned, and the children could not grow.” (translations is ours). *Fragmentos de la Historia General y Natural de Gonzalo Fernandez de Oviedo, 1535*. Eugenio Fernández Méndez, *Crónicas de Puerto Rico. Desde la conquista hasta nuestros días (1493-1955)*. Editorial Universitara, Universidad de Puerto Rico, Río

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The Europeans found in Puerto Rico an island lavishly rich in water sources (**Fig. 1**). The first detail mention of the local rivers first appeared in the document known as *Memoria de Melgarejo*. Published in 1582, the narrative mentions most of the rivers of the island using the “native” designation for them. Almost every town, with the ironic exception of the settlement of San Juan in the islet in 1519, was formed around either a river mouth or along a river bank. By the end of the sixteenth century, the river mouths were the more populated and exploited areas throughout the island, with the settlements established along the flatlands and valleys of the coastline. On the northern coast, permanent settlements developed along the margins of the rivers Loíza, Bayamón, Toa, Cibuco, Arecibo, Camuy and Guajataca. In the west, towns were born along the Culebrinas, Guaurabo y Guyanabo Rivers. The southern inhabitants established their European settlements in the mouths and banks of the Guadianilla, Tallaboa, Portugués, Jacaguas, Coamo, Salinas and Guamaní rivers. A similar process took place in the east coast nearby the fresh waters of the rivers Maunabo, Guayanes, Humacao, Dagua and Fajardo.³

During the following centuries, the presence of those bodies as sources of potable water and its relation to the fertility of the land was still praised by local and foreign observers. In 1899, William Dinwiddie, describing the new colony acquired in the Caribbean after the Spanish American War, mentioned that “*much of salubrity of the Puerto Rican climate arises from the fact that the island has a remarkable number of fast-flowing rivers. It is estimated that there are fifty-one large rivers and over 1200 small streams, creeks and rivulets which find their way through the interlacing mountains, deep gorges, and across fertile bottomlands to the encircling oceans.*”⁴ That very same year, the American naturalist Frederick A. Ober, indicated that “*Though few of the rivers are navigable for any distance above their*

Piedras, 1981, 33-106.

³ Memoria y descripción de la isla de Puerto Rico mandada a hacer por S. M. el Rey Don Felipe II en el año 1582 y sometida por el ilustre Señor Capitán Jhoan Melgarejo, Gobernador y Justicia Mayor en esta ciudad e isla. Eugenio Fernández Mendez. *Crónicas de Puerto Rico*, 107-134.

⁴ William Dinwiddie, *Puerto Rico. Its Condictions and Possibilities*. New York and London. Harper & Brothers Publishers. 1899.

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mouths, yet no many countries of Puerto Rico's extent are watered by so many streams'.⁵

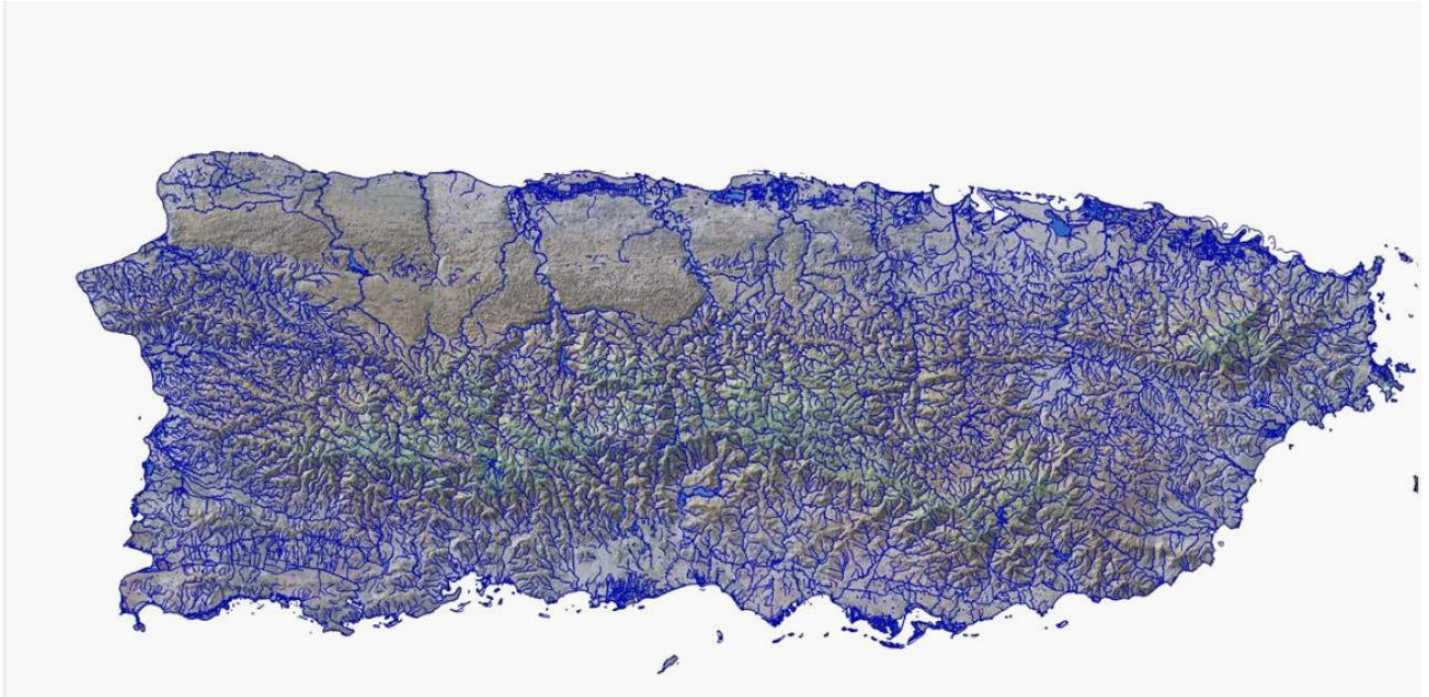


Figure 1. Rivers and streams in Puerto Rico. In the north-northwest karst region, most of the water bodies are underground.

The population in the island still depends today of the very same bodies of water for their daily consumption. In 2014, a total of 675 million gallons per day (mgd) of fresh water were withdrawn and delivered to satisfy the demand of approximately 3.7 million residents.⁶ Water diverted from streams, rivers, reservoirs and aquifers, as well as water pumped from wells, constitutes the main source of water for the 78 municipalities of the Commonwealth of Puerto Rico.

Among these sources, the thirty-six reservoirs in the island are the main producers of potable water. Two government agencies are mostly responsible for the management and production of water supplies, either for personal, industrial, commercial, agricultural, and other

⁵ Frederick A. Ober. *Puerto Rico and Its Resources*. New York. D. Appleton and Company, 1899.

⁶ U.S. Geological Survey. Fact Sheet 2015-3044. July 2015.

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uses: the *Autoridad de Acueductos y Alcantarillados (AAA)* y la *Autoridad de Energía Eléctrica (AEE)*.⁷ The AAA serves water for public use to 99% of the residents in the urban centers. Another 125,000 rural or suburban residents get their water supplied through community operated water systems.⁸ In 2014, the thirty-six reservoirs provided 470 mgd to the AAA, for 72% of the needed water for public use. The other 28% was extracted from six hundred deep wells dispersed primarily through the southern and northern coastal alluvium valleys. The water used by the industrial sector is mostly produced in the Inferior Aquifer in the northern karst region between the towns of Manatí and Barceloneta. While the agricultural producers in the northern and southern part of Puerto Rico obtain their water from irrigations systems built between 1908 and 1952, today administered by the AEE.

Even though water accessibility has been a determining factor in the process of human settlements of the island from the very early start until present time, an effort to regulate the use of such vital liquid was not established until the 1840s. During the last sixty years of Spanish control upon the island, due to economic factors, access to water sources became extremely significant to very particular economic forces. The insertion of the island within the worldwide market of sugarcane and coffee production created a strong need among the landlords to acquire direct and permanent use of rivers and streams. The life-sustaining resource became a highly coveted commodity, source of class struggles, popular anger due to damaging monopolies and state and municipal intervention to umpire the struggling interests.

During the 19th century, to capture the needed waters, especially in the island’s southern region, owners of sugarcane and coffee haciendas built private waterworks systems of various lengths and complexity. From simple water deviation outlets, to stone dams to direct the river’s water flow. From open trenches in the ground to transport the water to the planted fields, to solid stone masonry works. From ground level channels, to brick and masonry elevated Roman-like aqueducts. Many of these systems traversed relatively long distances, sometimes passing nearby urban centers and crisscrossing open private and public lands to

⁷ The Aqueduct and Sewer Authority and the Electric Power Authority, respectively.
⁸ Inventario de Recursos de Agua de Puerto Rico, 2004.

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reach the irrigated fields, or to move machinery, leaving a trail of built resources still visible today, but not either understood or appreciated by the current untrained observer.

Equally significant, during the last decades of the 19th century, some of the mayor cities in the island were economically strong enough to build aqueducts systems to provide water directly to the homes of their urban dwellers. Many of these public constructions, no longer in use, have become part of the urban landscape. However, like the irrigation waterworks, the remains of these public works are no longer part of the collective memory and experience.

Some of the extant resources associated with these 19th century waterworks, are easily identifiable because of their visible prominence within the built landscape. Others can only be properly located by trained specialists in history, archeology and in industrial archeology, to identified and evaluate the integrity and ability of the resources in providing information in methods of construction and 19th century waterworks' engineering technics. A historical approach it's necessary to understand the social and economic context that provides significance to these resources, as well as to properly identify the documental primary sources needed for a successful tracking of the not easily identifiable extant resources.

II. *Becoming a Sugar Island*

During the1500s-1700s, Puerto Rico went through different stages of economic trends and served different purposes within the Spanish imperial design. The island started as a gold producing colony, but the resource was quickly depleted by mid sixteenth century. The scarcity of the precious mineral oriented the local economy towards agriculture. Simultaneously, the Spanish conquest of the mineral rich areas of New Spain (Mexico) and Perú transformed the island from a small contributor into Spain's commercial scheme to a major player in Spain's imperial project. Puerto Rico's geographic position at the eastern edge of the Caribbean made the island (especially San Juan, the Capital) one of the key frontier outposts of Spain's West Indies dominions.

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While San Juan became a military bastion, eventually enclosed by protective walls and seat of the Colonial officials, the rest of the island developed a different way of life. Puerto Rico’s western and southern areas created an economy based on subsistence farming, open to negotiations with the very same foreign countries opposed to Spain. Dedicated to agriculture and livestock production, lands were worked by the colonists with the reluctant help of the subjected native population (while they lasted), the black slaves and those poor whites and mulattoes who couldn’t afford their own land. The subsistence farming was oriented to the production of cassava, corn, tobacco, vegetables, plantains, rice, among other products.

With the first plants arriving in the island by the 1520s, sugar cane cultivation was one of the main activities by mid sixteenth century. The planting and the reaping of sugarcane were both heavy undertakings demanding considerable labor. The manufacture of sugar, even by the crude small-scale methods of the sixteenth century, required a crushing mill, and power to turn it. A small mill might be turned by a mule or an ox, or even by manpower; a larger one needed a water wheel or windmill. Coppers and furnaces were needed for boiling, and pots for crystallizing the juice. Carts, and beasts to pull them, were necessary for transporting cane; and the manufactured product, being full of molasses, had to be shipped in casks. The production of sugar in quantities large enough for export, therefore, required considerable initial capital and a large labor force, including unskilled hands for fieldwork and skilled men for the process of manufacture.

Spain helped to promote an active sugar industry through loans and credit lines to the colonists to acquired slaves and equipment. By 1564 there were in Puerto Rico ten sugar mills with an output of 500,000 pounds of sugar.⁹ But this bright beginning of the industry didn’t last long. Due to lack of funds and investment capital, high prices of slaves, a lack of ships to transport the sugar to Spain, and other factors, the output and number of sugar mills drastically declined. In 1602, only eight mills were in operation; by 1647 only seven were left.¹⁰

⁹ Arturo Morales Carrión, *Puerto Rico. A Political and Cultural History* (New York: W. W. Norton & Company, Inc., 1983), 35.
¹⁰ Ibid.

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Throughout the last decades of the sixteenth century and most of the seventeenth, the islanders, especially those located away from the inquisitive eyes of San Juan, developed a well-organized illegal commerce with Spain's perennial enemies: the French, the British and the Dutch. By the seventeenth century, the British colonies in North America became partners of Puerto Rico in the lucrative illegal trade also.¹¹

When Field Marshal Alejandro O'Reilly made his landmark inspection of Puerto Rico by the 1760s, he found illegal commerce flourishing throughout the entire island, especially in the western and southern parts, with all kind of people involved, including high ranking officials of the Spanish Crown.¹² Representing the Crown's interests, O'Reilly suggested crucial changes in his report. As a professional soldier, O'Reilly suggested changes in the military structures and improvements in the defense system. But he also recommended social and economic policies: the increase of authorized commercial ports, a policy to promote the immigration of people with strong economic resources whose capital could be used in the agricultural industry, the increase of sugar mills and a land reform, among others.

Alejandro O'Reilly's project was part of the Spanish Crown's new interest in turning Puerto Rico into a productive and prosperous colony, not just a military bastion. Agricultural production, the immigration of men with capital willing to invest, a more progressive political administration and an active commerce with Spain and its allies, were the central points of this new approach. During the late 18th century and the beginning of the 19th century, many of O'Reilly's recommendations became part of the official policies. These local policies combined with external factors to make the sugar industry a major economic force in the island during the 1800s.

The Atlantic World changed drastically during the last decades of the eighteenth century and the early nineteen-century. For one, a small group of thirteen colonies in the eastern seaboard of North America officially defeated the British Empire by 1783 and emerged into the international community as the United States of America. In the Caribbean, the

¹¹ Arturo Morales Carrión, *Puerto Rico y la lucha por la hegemonía en el Caribe. Colonialismo y contrabando, siglos XVI – XVIII* (Río Piedras: Editorial de la Universidad de Puerto Rico, 1995).

¹² *Memoria de D. Alejandro O'Reilly sobre la Isla de Puerto Rico, Año 1765.* Alejandro Tapia y Rivera: Biblioteca

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foundation of every colonial discourse was dislocated by a successful revolution of slaves in Saint Domingue. In between the crucial years of the French invasion of Spain in 1808 and *La Batalla de Ayacucho* in 1824, Spain lost its great empire in the mainland, reducing its colonial zone to just Cuba and Puerto Rico. All these events had a direct effect upon the island’s sugar industry.

During its colonial period, the United States developed a very significant rum-production industrial complex, mostly located in the Northeast colonies. In the 1660s there were more than 60 distilleries in Massachusetts alone, producing in excess of 2.5 million gallons.¹³ The rum produced in the Northeast distilleries became the main commodity connecting the area to the slave trade. In Africa, merchants could buy adults slaves for 110-130 gallons of rum or children for about 80 gallons.¹⁴ Once brought into the West Indies, the enslaved would produce sugar; yielding molasses so the Northern colonies’ distilleries could produce their rum, to exchange for more slaves, in a vicious cycle of profit. The industrial complex of distilleries in the Northeast was dependent of the Caribbean molasses. After breaking-up from the British Empire in 1776-1783, the New England merchants oriented their cargo ships toward the French and Spanish Caribbean. However, the French connection was about to explode.

Just as the United States was beginning its republican experiment, the Haitian Revolution shook the Atlantic World. By the 1790s, the jewel of the French colonial empire, *Saint Domingue*, began its violent and destructive fight for independence. The Haitian Revolution shut-down the most productive colony of all, creating a vacuum for the cocoa, coffee, and of course, sugar markets all over the world. The revolution created a social and economic instability in all the French West Indies and sent a troublesome message to every imperialist representative of the European community in the Caribbean.

With the French and British Sugar Islands off-limits, the United States businessmen looked toward Cuba and Puerto Rico for their molasses. The righteous violence showed by the

Histórica de Puerto Rico (Ed. Instituto de Literatura, San Juan, 1945), 526-555.

¹³ J.H. Parry, Philip Sherlock and Anthony Maingot, *A Short History of the West Indies* (Fourth Edition, MacMillan Caribbean, 1987), 93-107.

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slaves against their former French masters promoted a human and capital exile from the new Republic of Haiti. Puerto Rico became one of the main recipients of Haiti's French colonists, which arrived with their investing capital, technical knowledge, and some, even with their human property.¹⁵ Established mostly in the island's southern sector, the new arrivals contributed greatly to the nineteenth century sugar-production-boom.

A similar exile process occurred between the 1810s – 1820s, caused by the disintegration of the three-hundred-years-old Spanish Empire in the Americas. As it lost all his colonies in Central and South America, social groups unconditionally loyal to Spain (military officials, merchants and landlords of the *Peninsulares'* elite) took refuge in Puerto Rico during and after the Latin American's wars of independence, bringing their capital, commercial expertise, their enslaved people and their political conservatism. The loss of the continental colonies re-routed Spain's emigration toward Cuba and Puerto Rico. The combined effort of both *Peninsulares* and foreign immigrants, was a significant engine behind the initial take-off of the sugar plantation economy during the early nineteenth century.

Also significant to the sugar industry in Puerto Rico was the 1815 *Real Cédula de Gracias*. On August 10, 1815, King Ferdinand VII approved the *Real Cédula* which granted Cuba and Puerto Rico the right to have commercial ties with countries which were in good standing with Spain, and free land and special privileges to any Spaniard willing to relocate and settle in those territories. The *Cédula* established that foreigners from friendly countries, as long as they were Catholics, could settle in the island with all their properties (including slaves). In the average, all white legal settlers, Spanish or foreigners, were offered six acres of free land for each family member and three additional acres for each slave. After a five-year waiting period, the foreign settlers could gain the citizenship and full title of their lands. The new naturalized citizens were authorized to get involved in the maritime commerce and become full-fledge merchants.¹⁶ The decree authorized free trade between the island and

¹⁴ Hugh Thomas, *The Slave Trade* (New York: Simon & Schuster, 1997), 519.

¹⁵ Estela Cifre de Loubriel, *La inmigración a Puerto Rico durante el siglo XIX*, (San Juan: Instituto de Cultura Puertorriqueña, 1964).

¹⁶ Archivo General de Puerto Rico (AGPR). Real Cédula de Gracias de 1815.

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Spain for fifteen years. Commerce with other Spanish colonies was also authorized. To protect local production, free importation was permitted, except for sugar, rum, molasses and tobacco.

The immigrants attracted by the 1815's concessions, coming into the island from Spain, France, other European countries, from nearby Antilles and even the United States, brought with them not only means of production, but also ideas, experiences, commercial connections, skills and a strong taste and desire for profits, following the capitalistic revolutions that were sweeping Europe and the United States. The free commerce, the protective tariffs, the elimination of taxes upon agricultural equipment and machinery, the immigration of personnel with investing capital and knowledge of sugar manufacturing, a major availability of labor (free and slave), facilitated the development of the sugar industry. Significant also was the introduction, probably by end of the 18th century, of the Otahiti, a new variation of the sugarcane plant that was more productive due to its thicker and juicer constitution.

These local and external factors combined to create the proper conditions for the increase in sugar production. In his 1788 work, Fray Iñigo Abbad y Lasierra indicated that 3,156 *cuerdas*¹⁷ were planted with sugarcane island wide, producing 273,725 pounds of sugar. By 1830, there were 11,000 *cuerdas* covered by the sweet plant, producing over thirty-four million pounds of sugar.¹⁸ In 1862, fifty-five thousand *cuerdas* were used as sugarcane fields.¹⁹ In Lasierras's work third edition, published in 1866, and brilliantly annotated, updated and corrected by José Julian Acosta, the numbers in sugar production from 1828 to 1864, showed the remarkable increase.²⁰

¹⁷ One *cuerda*, sometimes called the "Spanish acre" because of their nearly same size, equals to 0.971 acre.
¹⁸ Pedro Tomás de Córdova, *Memorias geográficas, históricas, económicas y estadísticas de la isla de Puerto Rico*. San Juan: Imprenta del Gobierno, 1831-33, Vol. 2, 406.
¹⁹ Francisco A. Scarano, *Haciendas y barracones: azúcar y esclavitud en Ponce, Puerto Rico 1800-1850*. Ediciones Huracán, 1992, 52.
²⁰ Iñigo Abbad y Lasierra, *Historia geográfica, civil y natural de la isla de San Juan Bautista de Puerto Rico*. Nueva edición, anotada en la parte histórica y continuada en la estadística y económica por José Julian de Acosta y Calbo. Ediciones Doce Calles, 2002, 409. For the complete table, see the cited reference.

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Year	Sugar (pounds)
1828	18,782,675
1830	34,016,375
1835	45,857,450
1840	81,793, 693
1845	92,904,423
1850	112,129,432
1855	101,437,866
1861	131,035,471
1864	92,511,988

The development of the sugar industry in the initial decades of the 19th century brought significant changes both in the human geography and the spatial distribution of the sugarcane crops. The planting and the reaping of sugarcane were both heavy undertakings demanding considerable labor. The manufacture of sugar, even by the crude small-scale methods of the sixteenth century, required a crushing mill, and power to turn it. A small mill might be turned by a mule or an ox, or even by manpower; a larger one needed a water wheel or windmill. Coppers and furnaces were needed for boiling, and pots for crystallizing the juice. Carts, and beasts to pull them, were necessary for transporting cane; pasture lands were required to feed the workings beasts and the manufactured product, being full of molasses, had to be shipped in casks, requiring either to buy the caskets or build them. The production of sugar in quantities large enough for export, therefore, required considerable initial capital and a large labor force, including unskilled hands for fieldwork and skilled men for the process of manufacture. During the 1800s, the sugar production process would be ten-folds more complex, requiring the investment of large capital, the constant acquisition of new land and labor, a harder work discipline and an intensified effort, hardly matched by the production of any other crop.

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The development of Puerto Rico as a sugar island is more easily understood when specific areas are dissected to see the actual changes. The city of Ponce, located in the southern region of the island, it's a good example. During the first four decades of the 19th century, Ponce's economy make a definite turn towards sugar production with all its implications: its insertion within the world-wide sugar market, an intensive augmentation in the use of slaves as the main labor force, the concentration of the economic power within the landlord class and the domination of the fertile valleys of Ponce by the sugarcane plant over other crops. In 1776, according to Abbad y Lasierra, Ponce had 250 *cuerdas* of sugarcane.²¹ By 1813, there was a slight increase with 351 *cuerdas* producing 25 tons of moscavada.²² However, by 1821, six years after the Cédula de Gracias came into effect, there were over a thousand *cuerdas* planted with sugarcane, producing 1,350 tons of sugar.²³ By 1828, Ponce was dedicating 1,634 *cuerdas* of their fertile land to grow the plant, and it had registered 36 wooden and 49 iron sugar mills, producing 5,701,900 pounds of the coveted commodity.²⁴

Ponce it's the appropriate example as not only shows the growing tendencies in a specific municipality, but it also represents the new geography of the industry. During its early stages, sugar production was mostly concentrated in the northern region of the island. However, the 19th century boom gravitated heavily towards the southern, southwest and southeast coastal regions. The southern portion of the Continental Divide became the new center of economic power. The numbers provided by Pedro Tomás de Córdoba confirmed the re-orientation process of the industry. In 1828, fifty-seven municipalities were producing sugarcane. Out of this total, 15 produced less than a ton; 18, between 1 to 50 tons; 10 towns

²¹ Iñigo Abbad y Lasierra, *Historia Geográfica*, 328.

²² AGPR. Fondo: Gobernadores Españoles Serie: Asuntos políticos y civiles Caja 11, "Estado que manifiesta las producciones agrarias del pueblo de Ponce, 1813".

²³ Francisco A. Scarano, Inmigración y estructura de clases: los hacendados de Ponce, 1815-1845, 26. Francisco A. Scarano, editor. *Inmigracion y clases sociales en el Puerto Rico del siglo XIX*. Ediciones Huracán, 1981.

²⁴ Pedro Tomás de Córdoba, *Memorias geográficas*, Tomo II, 257-258.

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produced between 51 and 200 tons; 11, between 201 and 1000 tons. Only three municipalities produced over 1,000 tons of sugar: Mayaguez, Guayama and Ponce. Together they represented 54% of the total production, even though all three together had 88 sugar plantations, out of a total of 276 operating that year. By the early 1840s, the southern coast, which included Ponce, Juana Díaz, Santa Isabel, Salinas, Guayama and Patillas, became the leading region in the sugar industry.

III. Coffee, the Gold from the Highlands

The last decades of the 19th century saw the golden age of the coffee industry in Puerto Rico. Growing in the island since its insertion in 1736, by the early 19th century, coffee was one of the main crops produced in Puerto Rico for local consumption. It was also a very significant exporting crop. Alejandro O'Reilly in his 1765 report to the Spanish Crown indicated that coffee was already being exported from Puerto Rico, albeit in small quantities.

Usually associated with the mountain region, during the 18th century and early 19th century, coffee was part of the coastal landscape. The plant was frequently mentioned by Abbad y Lasierra as part of the coastal towns' crops. When describing the region between Salinas and Santa Isabel, Abbad y Lasierra mentioned that "*much coffee is produced, of which there are many beautiful plantations along the coast*".²⁵ When describing the flat coastal lands of Ponce, the East African plant became again the most relevant crop:

*"La principal cosecha es la de café: asciende algunos años a 187,932 arrobas que todo pasa a los extranjeros, igualmente que las maderas y ganados sobrantes. Toda la tierra que se extiende á lo largo de la costa está poblada de haciendas de café que fructifica pasmosamente".*²⁶

However, during the years 1800-1840, sugar became the dominant crop in the coastal flatlands, displacing the coffee production and the coffee producers up into the mountain

²⁵ Iñigo Abbad y Lasierra, *Historia Geográfica*, 300. (Translation is ours)

²⁶ *Ibid.* 327. ("Coffee is the main crop, some years ascending to 187,932 arrobas all going to the foreigners, just like the surplus of wood and cattle. All the land that extend along the coastline is full of coffee haciendas that are astonishingly fruitful"). (Translation is ours)

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regions. In the highlands, the coffee plant found the ideal fertility, humidity, temperature and shade (as coffee was planted under large shaded trees, hardly available in the coast) for its perfect blossom. The small farmers in the mountain found in the plant the perfect companion for their others crops. While cassava, corn and plantains were grow as sustenance crops, coffee was sold in town as a cash crop, providing the small farmer the hard currency needed to buy those things that he couldn't produce. The coffee grown in the small farms was bought by middlemen/commercial houses with the proper contacts in the international market. Eventually, the Puerto Rican coffee became a coveted commodity highly appreciated and sought after by the gourmet consumers, especially those in the European market. By 1846, a hundredweight of Puerto Rican coffee was sold in the international market for six pesos; by 1860, it was twice that much. By 1886, the price of one hundred pounds sold for twenty-one pesos. While in 1894, it cost thirty-two pesos to acquire one *quintal* (100lbs.) of the best Puerto Rican coffee in the international market.²⁷

Just like with the sugarcane in the early years of the 19th century, during the 1860s, certain external factors facilitated the explosion of the local coffee industry. For one, the largest coffee producer by the end of the 18th century, the French colony *Saint Domingue*, never recover its placed in the coffee market after its destructive independence revolution into becoming Haiti. The destruction of many coffee plantations in Cuba during its Ten Years War (1868-1878) allowed Puerto Rico to replace its colonial sister in Spain's coffee market. However, the most significant external factor was the 1876 commercial agreement between the United States of America, the world largest coffee consumer, and Brazil, the world largest coffee producer. The United States practically absorbed for many years the entire Brazilian production, creating a worldwide vacuum in the coffee market, highly advantageous for other coffee producers, Puerto Rico among them. By 1896, at the moment of its highest price, Puerto Rico exported 58,600,000 pounds of coffee, mostly to the European market. In 1899, out of a total of 396,000 cultivated cuerdas, 197,000 were planted with coffee, with sugarcane

²⁷ Guillermo Baralt, *Yauco o las Minas de Oro Cafetaleras*, 1756-1898. San Juan: Model Offset Printing, 1984. 37

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in second with 73,000 cuerdas.²⁸ Most definitely, by the end of the 19th century, coffee was king.

Romanticize many times by current commercial interests and governmental campaigns, the cultivation of coffee is usually exalted as part of a glorious cosmopolitan period when our coffee was a prime commodity at the cafes in Hamburg, Le Havre, Southampton, Bremen, and even the Vatican, among other coffee capitals in Europe. Although historically correct, it also needs to be remembered that, as Anthony Wild recalled, “*economies that are historically coffee-based have created the ground rules by which a ruling oligarchy can impose its will on the unrepresented masses*”.²⁹ In Puerto Rico, coffee farming during the 19th century was associated to debt peonage, labor exploitation, small farmers’ displacement, land speculation, property foreclosures, class oppression and social resistance.³⁰

During the 19th century, the manufactured coffee had two commercial trends: local consumption and as an export good. Each trend involved different steps in the manufacture process, although they were developed one upon the other. The small farmer usually produced a low quality product as a cash complementing crop, to be sold locally. As coffee became a highly priced commodity, a larger number of powerful landlords and commercial houses got directly involved, not just in selling the product, but in its actual preparation. The large coffee barons’ plantations, and those owned by commercial houses, added industrial steps to produce a higher quality coffee.

The coffee berry is formed by two seeds, or beans, protected by a fine pellicle (parchment), a fleshy pulp and the husk. The berry could it be processes in two ways: the dry method, in which the berry is dried with the pulp and husk intact; and the wet method, in which the berry is first peeled. The first method produce a lower quality coffee that required only drying of the berry to prevent spoilage. Once dried, it was peel-off. This type of coffee, called *café pilado*, was normally the one produced by the small farmer up in the highlands, using

²⁸ Report of Military Governor of Porto Rico. Washington Government Printing Office, 1899, 187.

²⁹ Anthony Wild, *Coffee: A Dark History*. New York: W.W. Norton & Co., 2005, 15.

³⁰ Fernando Picó, *‘Lucha en el cafetal: resistencia a la subordinación económica y social en la zona cafetalera puertorriqueña en la segunda mitad del siglo XIX’*, in *Al filo del poder: Subalternos y dominantes en Puerto Rcio, 1739-1910*. Río Piedras: Editorial de la Universidad de Puerto Rico, 1993.

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family members and maybe some *agregados* as hand labor. It was sold as a cash crop to the nearest town's store (*pulperias*), passing it to the customers.

To produce a better quality raw coffee, the so called wet method was used. It required to separate the coffee berry from its covering (*despulpar*). The stripped berry was later placed in a tank of water where the pulp was eliminated by fermentation and washed. The freed berry was then dried outside in the sun in the drying court (*glacis*), or in large wooden drawers or in the attic of the main factory building. At the end of the drying procedure, the bean had a fine, light brown skin, and it was known as *café pergamino* (parchment coffee). In many coffee plantations the parchment coffee was the end product. On others, the hulking and ventilating of the parchment coffee was carried out, removing the parchment from the bean. At some instances, the de-parched seed was even polished, making the raw seed to shine and stand out when compared to other non-polished seeds.³¹ This better quality, highly processed, shining raw seed was the one exported into the European market. Due to the use of different type of machinery to produce this type of seed, the process was out of reach to the small famers. It was make by large coffee plantations and commercial houses that specialized in the process.

During the last decades of the 19th century, especially in the golden years of 1880-1899, the plantations that manufactured coffee as an exporting good, were heavily dependent in water sources as a propelling force to move hydraulic wheels and turbines, using articulated systems of dams, canals and aqueducts to carry the water needed, and then returned to the river via another canal system. The plantation near the water sources always enjoyed its accessibility. Those farther, besides the dams and canals, also built artificial ponds and storage facilities to have water available, not only as a hydraulic force, but also for the peeling and fermentation tanks.

On either case, just likes its sugar estates counterparts, the large coffee producers strived to access and control the nearby water sources.

³¹ For a more detail description of the coffee making process, see Luis Pumarada O'Neill, *La Industria Cafetalera*

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IV. Accessing the Water Sources

The sugar production’s gravitation towards Puerto Rico’s southern area placed a high demand upon the waters sources available. Despite the island’ small size, the southern region had (and still have) very particular topographic, hydrographic and climatic conditions. The south coastal valley runs westerly uninterrupted from Patillas to Ponce at the foot of the Cordillera Central (the Continental Divide) that centrally traverses the island from east to west. The valley’s flatlands extend for about thirty miles, comprising almost 115,000 acres. The general rain pattern in the valley is in many ways determined by the Cordillera Central. The mountain range forms a barrier that forces the eastern-northeastern winds from the Atlantic, loaded with humidity, to rise toward the atmosphere and later fall as rain in the Cordillera’s northern side. By the time the air masses crosses into the southern region, it has lost most of the humidity, considerably reducing the precipitation in the fertile but dry valley, which has the lowest rain levels in the island.³² There are differences even within the valley itself. As it runs from east to west, the rainfall decreases, with Guayama receiving about sixty inches of rain a year, while Ponce receives about eighteen inches. Also, because the Cordillera Central is closer to the Caribbean shore line than to the Atlantic’s, compared to the ones in the northern valley, the rivers in the southern coast are shorter and run faster towards the ocean.

These characteristics of the southern region were well-known by the landlords, the professionals and the government officials associated or interested with the agricultural process. As such, a concern about the water sources and its conservation was shown during the early years of the 19th century. In 1824, Governor Miguel de la Torre announced a number of ordinances attempting to establish a preservation policy within the municipalities.³³ The governor called to the attention the worrisome destruction of trees near the river beds and banks, affecting the quantity of usable freshwater for consumption and agriculture. In some occasions, the municipalities’ authorities took the initiative in trying to enforce a conservationist stand. In 1844, for example, the mayor of Ponce, Salvador de Vives, tried to remedy the

de Puerto Rico, 1736-1969. Oficina Estatal de Preservación Histórica. San Juan, 1990.
³² Rafael Picó, *Nueva geografía de Puerto Rico. Física, económica y social.* Río Piedras: Editorial Huracán, 1969, 83.

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growing deforestation by making it illegal to clear trees on the slopes and summits of mountains or on the banks of creeks and rivers. In addition, landowners near the headwaters of rivers and creeks and along any banks that had been cleared were required to plant trees chosen from among a list of those that grew fastest in the island’s soil and climate.³⁴

In 1847, an executive order came down from the central government for all the municipalities to provide a survey of their water resources including rivers, creeks, streams, spring waters and fountains. Ideas and suggestions on how to protect the precious liquid were also requested from the city’s councils. The information provided by some of the municipalities is illustrative. Adjuntas, for example, indicated having twelve rivers, twenty-four streams, one hundred and ninety-four brooks and ten spring waters. The report mentioned that all the bodies of water were permanent, as they never dry-up, even so they can lower their current and intensity. Adjuntas’ mayor indicated that because of the municipality’s uneven and rough topography, the waters were not very useful locally, but very significant to bordering towns like Añasco, Arecibo and Ponce. It was mentioned that two of the rivers borne in Adjuntas, along with five of the streams and six of the brooks, found their way to the Caribbean through Ponce.³⁵

However, the 1840s efforts in establishing a public policy to protect the water sources were more a reactive action than a pro-active stand. During the previous years, specifically between 1838 and 1842, a terrible succession of droughts impacted the southern region, severely reducing the sugar production in the southern haciendas.³⁶

By the early 1840s, regular access to water was a survival requirement for the sugar industry’s producers south of the Cordillera Central. Historians had concluded mostly that in a pre- capitalist society, access to land it’s the source of class power. However, it should probably be included in that statement that “access to productive land” is the source of power and as such, control of the water sources is a basic requirement for success. The droughts of

³³ Francisco Ramos. Prontuario de Disposiciones Oficiales.

³⁴ Guillermo A. Baralt. *Buena Vista. Life and Work on a Puerto Rican Hacienda, 1833-1904*. The University of North Carolina Press, 1999, 13.

³⁵ AGPR. Fondo: Obras Públicas. Serie: Aguas. Legajo 190. Caja 465.

³⁶ Op. Cit., 34.

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1838-1842, became the catalyst that initiated the race between the landowners for control of fresh water sources. Growing a plant like the sugar cane that needs approximately seventy to seventy-five inches of well distributed water throughout the year, access to the liquid became a source of struggle among the landlord class itself. It also dragged the regular population whose life depended in access to the needed liquid and the state and municipal officials that attempted to mediate the conflicting interests.

The first water concession officially recorded island wide, was granted in Ponce in February 20, 1841, to Don Luciano Ortiz. The landlord, owner of *Hacienda Portugués*, a sixty cuerdas sugarcane hacienda, was authorized to take water from the river of the very same name (Portugués River), one of the six mayor rivers that crisscrossed the municipality. The water was not for irrigation purposes, but to be used as a hydraulic force to move the sugar mill. Ortiz was authorized to build a dam of loose rocks across the river at the nearest proximity point between the river and the hacienda. The dam was to divert the water into a masonry canal, directly to the factory house. The amount of water to be taken was not specified.³⁷

During the 1840s, concessions allowing water rights over almost every major river, south of the Cordillera Central, were approved by the state government (**Fig 2**). In the Portugués River, in Ponce, we found that Manuel Moler y Guell, on December 16, 1842, received permission to extract water to irrigate 117 hectares. Wichers and Company received a concession on July 11, 1844, to irrigate *Muñiz* and *Parnasso*, both sugarcane haciendas. The merchant and landlord Juan Cortada, was authorized on November 5, 1842, to take water for *Palmarito*, a 78.6 hectares sugar farm. On December 16, 1843, the owners of *Quemado*, received permission to take 15.49 liters of water per second from the Portugués, with another concession approved in 1870 for an additional 70 liters per second, to irrigate 106.67 hectares.³⁸

³⁷ AGPR. Fondo: Obras Públicas. Serie: Aguas. Legajo 185. Caja 464. "Relación de los aprovechamientos de aguas que existen en esta jurisdicción (Ponce), 1870". The record shows a water permit authorized in 1831, but ended in 1839.

³⁸ AGPR. Fondo: Obras Públicas. Serie: Aguas. Legajo 190. Expediente 2. Caja 465. Concesiones de aguas hechas en la isla de Puerto Rico durante el gobierno español y el gobierno americano (Para riegos), 1907,9-11.

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to irrigate his 171 hectares farm, the *Ursula*. While José Torruella, on October 7, 1843, was granted 39 liters p/s for his 79 hectares farm, *Unión*. Almost two years later, on September 26, 1845, David Laporte received his concession of 102 liters p/s to irrigate *Serrano*, a 204 hectares estate.⁴⁰

The control over the waters of Descalabrado River, a natural border between Juana Diaz and Santa Isabel, didn't took place during the 1840s. However, it's worth the mention as its waters became associated to just one particular landlord: Juan Cortada. The first concession was given to the powerful landlord and merchant on August 27, 1868, allowing Cortada to take 165 liters for his 235 hectares sugar estate, *Descalabrado*. On June 18, 1872, he was granted the use of the river's spring, winter and torrential waters.⁴¹

The waters of the Guamaní River, in the Guayama municipality's jurisdiction, were also allocated during the 1840s. On May 18, 1849, Florencio Capó was authorized to take water to irrigate *Tuna*, a sugar estate. On the very same date, Capó also received permission to drain the river for another sugar hacienda, *Caimital*. José Antonio Vazquez, on May 18, 1849, was granted waters from the Guamani for his estate, *Olimpo*. Closing the decade, the Sisters Curet and Juan Jouver, were authorized on November 6, 1850, to use the river to irrigate two of their sugar haciendas, *Santa Elena* and *Felicidad*. In any of the mentioned concessions in Guayama, the amount of water was specified.⁴²

The rivers, streams and even spring waters of the west and southwest region, were also claimed by sugar estate barons during the 1840s, as part of the water-access-race caused by the previous year's droughts. Tomás Ramirez de Arellano, a resident from San Germán, was granted in 1846, the use of waters from Susua River to irrigate 200 *cuerdas* and move his sugar mill. In 1846, José Maria Quiñones, also from San Germán, was authorized to extract water from Susua and Caños rivers for his 400 *cuerdas* sugar estate and to operate the sugar mill. The Carmen Suarez de Mangual's Succession was authorized in April 1849 the use of Mayaguez River to irrigate *Carmen's* 150 *cuerdas*. On February 6, 1843, Juan María

⁴⁰ Ibid., 18-21.
⁴¹ Ibid. 21-22.
⁴² Ibid. 23-25

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Antongiorgi, from Yauco, received authorization to take water from Yauco River for his 150 cuerdas hacienda and sugar mill. Augusto Merlo, from Peñuelas, received a grant signed on July 15, 1843, to use the water from Peñuelas River. Pedro Villot, from Guayanilla, was authorized on February 17, 1844, the use of a local spring water to irrigate 118 cuerdas. Miguel Saliva, also from Guayanilla, was granted permission on June 17, 1844, to retrieve the waters from Guayanilla River to feed 317 cuerdas for his haciendas *Faro* and *San Colombano*.⁴³

The acquisition of water concessions was a constant activity throughout the last five decades of the 19th century. For the sugarcane industry south of the Continental Divide, acquiring water rights became a basic economic need. Many historians and other researchers have largely commented about the shortcomings of the Puerto Rican sugar industry during the 19th century: lack of investment capital, the absence of local banks and financial institutions, poor technological development, dependence on slave work (an internationally dying institution at the time), among others. However, the natural conditions of the region are usually absent on those analysis. In the southern valleys, an insufficiency of precipitation during just one single crop, was enough to dislocate the entire system.

This hard and dry reality was always present in the minds of the southern landlords. When the owners of *Quemado*, once the larger sugar estate in Ponce, applied for a tax exemption in the 1860s, their opening statement mentioned that, *“In places that, like in Ponce, rains just a little, irrigation is not just needed, is absolutely indispensable. Haciendas without irrigation are the ruin of their proprietors.”*⁴⁴ A similar hard-learn appreciation shows in Manuel de Jesús Toro’s 1847 request to use the waters from the Guayo River in Juana Díaz: *“The complete experience, that has been learned, is that no hacienda can exist in this coast, without an irrigation to fertilize the cane that produces sugar”*.⁴⁵ During the 1860s, landlady Soledad Renta was the owner of a 1,038 cuerdas cattle ranch, named *Descalabrado*, nearby the river of the same name in Santa Isabel. In 1868, Renta requested permission to use the

⁴³ Ibid. 28-36

⁴⁴ AGPR. Fondo: Obras Públicas. Serie: Aguas. Caja 464, Legajo 186, Expediente 3.

⁴⁵ AGPR. Fondo: Obras Públicas. Serie: Aguas. Caja 420. Legajo 51.

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river to irrigate 600 cuerdas in which she was planning to plant sugarcane. According to the submitted request, the ranch couldn't grow enough grass to feed the cattle, due to the droughts. But before she could switch to the "*expensive sugar crop*", she stated that "*is an indispensable necessity the establishment of an irrigation system, because without it, the owners' plans and pretentions would be unreal.*"⁴⁶ It is not surprise then, that by the end of the 1800s, the waters of almost every mayor river in the southern, southeast and southwest regions were claimed by the main sugar estates.

Just like their sugar landlords counterparts, the coffee producers were also very active in the process of acquiring water rights to move machinery at the large coffee plantations. Most of the recorded concessions were granted after the 1880s, precisely the starting period of the coffee golden age. On April 19, 1882, Celestino Mercado was granted water rights from *quebradas Collores y Palo de Pan* in Juana Diaz for its coffee water tanks. On June 1, 1882, Domingo Mariani, from Yauco, one of the most significant coffee municipalities, was authorized to take 150 liters per second from the Prieto River to be used as hydraulic force on his estate *Santa Clara*. On September 11, 1882, Martínez Hermanos in Mayaguez was granted 54 liters from Río de Mayaguez (Yaguez River) to move its iron wheel to peel-off the coffee seeds. On September 13, 1882, Ignacio Lazalde, a Ponce's resident, received authorization to take 146 liters per second from Río Cerrillos to move his coffee machinery; by March 14, 1884, the general government reported Lazalde's works as finished, consisting of a river dam and a distribution masonry canal. By December 1882, Basilio Pietri, a Corsican residing in Yauco was granted 100 liters from Rio Prieto to move various artifacts at his coffee estate *Salvación*. On June 15, 1883, the brothers Evaristo and Antonio Taraconte were granted 125 liters per second from Saltillo River to move coffee and sugar equipment in *Vista Alegre*, a hybrid estate in Adjuntas. Also in Adjuntas, on February 22, 1884, José Aparicio was granted waters from *quebrada Pueblo*, for his steam turbine used to peel and polish the coffee seeds. On June 3, 1884, Vilella Hermanos, from Lares, were granted 75 liters from quebrada Amor for their coffee machinery.

⁴⁶ AGPR. Fondo: Obras Públicas. Serie: Aguas. Caja 433. Legajo 78. Expediente 23.

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For the following years there were repetitious concession granted in the municipalities of Maricao, Juana Diaz, Adjuntas, Yauco, Lares, Ponce, and other municipalities historically associated with the coffee production.⁴⁷

V. Regulating the Water Sources

Before 1857, the water concessions were processed by the *Secretaría del Gobierno Civil*, under the direct orders of the designated Governor. The water rights were authorized based on reports provided by personnel assigned to the Spanish Military Engineers, who were responsible for evaluating the submitted water requests. This procedure lasted until August 10, 1857, when a royal decree created the *Dirección de Obras Públicas*, which assumed responsibility for the granting of water rights until 1898.⁴⁸

The water concessions granted during the 1840s and 1850s were very succinct in their provisions and even more in their requirements. As an administrative process, the early concessions lack essential information like duration of granted rights, amount of water to be taken by each licensee and the amount of land to be irrigated. The process of granting water rights during the early years was more a trial by error practice than an actual organized policy. The numbers included in the previous pages that actually mentioned the amount of water allowed (i.e., 120 liters per second) to a particular owner, were not available until the 1866's *Ley de Aguas* made it a requirement.⁴⁹

In 1853, what could be considered the first legal statute applied in the island related to water concessions and irrigation systems, came into effect. The royal decree was issue in Spain on June 24, 1849. Curiously, it was extended to Puerto Rico four years later, on July 9,

⁴⁷ AGPR. Fondo: Obras Públicas. Serie: Aguas. Legajo 190. Expediente 2. Caja 465. Concesiones de aguas hechas en la isla de Puerto Rico durante el gobierno español y el gobierno americano (Concesiones para motores hidráulicos), 1907.

⁴⁸ Jaime Bagué, El papel del agua en la vida de los pueblos y su desarrollo en Puerto Rico. *Revista de Agricultura de Puerto Rico*. Vol. 50, Num. 2, Julio a Diciembre, 1963.

⁴⁹ The data provided in the previous pages about water concessions during the early 1840s was listed in a 1907 document identified as *Concesiones de aguas hechas en la isla de Puerto Rico durante el gobierno español y el gobierno americano (Para riegos)* (refer to footnote #33). Concerning the amount of water to be taken, the documentation produced during the actual period of the initial concessions usually just said “no se fija” (“not establish”).

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1853, at the request of one single individual, José Antonio Vazquez, a landlord from Guayama. In a royal communication send to the Governor General, Fernando Norzagaray y Escudero, it was indicated that Vazquez made his request directly to Queen Isabel II. The letter to the governor reflected the royal knowledge about Puerto Rico's southern region particularities, as it mentioned that the law would benefit the landlords of the southern area, especially the ones from Guayama, Salinas and Coamo.⁵⁰

The 1853 decree consisted of a series of tax exemptions upon the land used and capital invested in the construction of irrigation systems. The capital used for construction purposes, including equipment, materials and labor, was tax exempted for ten years, starting from the moment when the waterworks were completed. In addition, although the value of the land tended to increase when irrigation systems were added, taxes to be paid by the owner upon the land were to be estimated using the values before the waterworks were built. This last exemption was also granted for a period of ten years. When the works had an industrial purpose, to use the water as a hydraulic force and not for irrigation, the owners were required to pay half the taxes during a ten years period, according to the nature of the industry.

The 1853 mandate included also a set of very significant provisions related to rights of ways. According to it, a landlord was authorized to build irrigations systems out of the limits of their legal properties. If the property owner needed to irrigate his lands using the public waters from a distant source, he/she could claim rights of way starting at the water intake, and throughout the entire layout of the irrigation canals, regardless if they traverse public or private lands. Private owners opposed to having their properties affected by the constructions, could be forced to accepted if it was determine by the local government that the works were all-around beneficial. The affected private owners had to be properly compensated.⁵¹

The 1853 law was made retroactive, allowing landlords to apply for the tax exemptions even if their irrigation works were built before the law was extended to the island. As it was in effect until the end of the 19th century, from the 1850s on, almost every new irrigation system

⁵⁰ AGPR. Fondo: Obras Públicas. Serie: Aguas. Caja 417. Legajo 41.

⁵¹ For a full version of the 1853 Royal Decree, see AGPR. Fondo: Obras Públicas. Serie: Aguas. Asuntos varios. Caja 464. Legajo 188. It was also published in *La Gaceta Oficial de Puerto Rico*, October 29, 1853.

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built was properly reported to qualify for the tax break. Also, many landlords submitted reports of constructions done previous to 1853, for the same reasons. Collectively, the requests for tax exemptions submitted by the southern landlords are an excellent source of information as many times they included the schematics of the irrigation systems, site plans, diagrams of the lands to be or been irrigated, extension of the canals, types of canals and itemization and cost of construction materials.

On August 3, 1866, what it's considered to be the very first *Ley de Aguas* properly compiled in Spain was made public. The law was the brainchild of a commission working since April 1859, to organize the diverse and conflicting water laws.⁵² However, due to the political unrest that eventually resulted in the formation of the Republic, the *Ley de Aguas* was never effectively enforced in country. Spain had to wait until 1879 to have a set of regulations to properly guide the use of the public waters. In Puerto Rico, however, the 1866 *Ley de Aguas* was made of public knowledge and locally extended on October 1866.⁵³ The documents accompanying the tax exemptions requests and submissions of new waterworks post 1866, clearly shown that the 1866 *Ley de Aguas* was locally enforced. The new law required more specific information, like the actual size of the lands irrigated and the amount of water to be taken. Most of the request post 1866, showed this data, among other, included in the submitted paperwork.

Because of their relevance, some of the articles in the 1866's *Ley de Aguas* deserved to be mentioned. However, in 1879, a new *Ley de Aguas*, was approved in Spain⁵⁴ and extended to the island seven years later, in 1886. The new law included and revised most of the issues addressed in the 1866 decree. It became the legal document guiding the use of the water resources in the Peninsula and Puerto Rico alike, until the close of the 19th century. To avoid repetition, the 1879 law could be used to explain some of the new dispositions.

⁵² Emilio Pérez Pérez, *Disposiciones decimonónicas sobre aguas. Ley de 1879*, 183-202. Ver, A. Gil Olcina y A. Morales Gil, *Hitos históricos de los regadíos españoles*. Ministerio de Agricultura, Pesca y Alimentación. Imprime: C. Marcelo, 1992.

⁵³ AGPR. Fondo: Obras Publicas. Serie: Aguas. Caja 465, Legajo 189. Expediente 2970. La Gaceta Oficial de Puerto Rico (the October 4, 1866 and October 16, 1866, issues) printed the entire August 3, 1866 *Ley de Aguas*.

⁵⁴ La Gaceta de Madrid. Jueves, 19 de Junio de 1879. Año CCXVIII. Número 170.

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The new laws allowed to apply for rights over water sources outside the boundaries of a particular plantation or hacienda, if the water was needed for irrigation or to move industrial equipment. Private owners of farm lands, along with private entrepreneurs or corporations could claim water rights to irrigate their lands or to provide irrigation services to third parties.

The regular population had the right to use the water sources, while they were running in their public/natural courses, to drink, wash their clothes and utensils, bathe, and as drinking trough for horses and cattle. The population could use the water running in private, open canals while these traverse public lands, for the mentioned uses, but without interrupting the water flow. However, access to water in private lands was prohibited to the general population.

Water sources within private properties were at the complete disposal of the land’s proprietor. The owner was authorized to use as much water as needed, but it could not change the natural course of the river or stream. The water not used had be allowed to run its course and the surplus water once used had to be re-routed to its original course. Once the water source was out of the private property, it became public domain.

A very significant disposition was about the length over the water rights. The law indicated that the water rights granted, as well as any irrigation waterworks (dams, water intakes, canals and their rights of way) built by the landlords, were to be considered theirs to perpetuity. These could be passed down as an inherited value or as part of a selling package. When the properties were sold by the owners that acquire the concessions, these rights were transferred to the new owners.⁵⁵ However, concessions to Societies and Corporations to irrigate third parties upon payments could not exceed a period of ninety-nine years, after which all the waterworks and water rights became of public domain.

The 1879 law (just like the 1866) established an order for the exploitation of the water sources. Concessionaries’ preferences were to be given to population water services, railroad water services, irrigation, navigation canals, industrial hydraulic force and hatcheries, in that order. Island-wide, concessions for irrigation purposes, were the majority ones.

⁵⁵ During the first decade of the 20th century, the government started to consider the possibility of building an irrigation system in the southern coast. All these 19th century concessions had to be revised and negotiated as they were still effective.

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All water rights requests had to include diagrams and drawings of the projected works, bid of specifications, memorial narrative and the project’s budget. The construction project had to be prepared by a certified specialist in the subject. The amount of land to be irrigated, the quantity of water in liters or cubic meters to be taken and how that amount was estimated, needed to be included also in the request. All request to extract more than 100 liters of water per second through the use of a dam, water mill, water pump or any other permanent work, had to be approved by the *Ministro de Fomento* (Ministry of Development). If the amount of water requested was less than 100 liters per second, the authorization was granted by the Governor, after revision by the *Jefatura de Obras Públicas*. To repair or preserve existing waterworks, no authorization was needed, although, the local agencies had to be informed of in-coming works.

Once accepted by the designated authorities, the water rights request had to be made of public knowledge through its publication in a newspaper. Those against the solicitation, had thirty days to properly submit in writing their opposition. The authorities were then responsible to evaluate the case in all its merits and deficiencies and emit a final determination.

Another significant disposition, included in both the 1866 and 1879 *Ley de Aguas*, was the creation of a legal body defined as *Comunidad de Regantes* (Community of Irrigators). It was mandated that when the concessionaries taken water from the same source reached the amount of twenty grantees and the combined land irrigated was two hundred hectares or more, such a body was to be properly established. The *Comunidad de Regantes* was to elect a Syndicate, with a President, a Vice-President, and vocals. The Syndicate was to look after the best interests of all members. It was authorized to establish a rigorous but fair water-taking schedule among the grantees. In times of low water levels, the Syndicate could organize a strict water-shift, depending in the size of each irrigated lot and a proper evaluation of all the grantees needs. The Syndicate could also allocate funds to either built or maintain existing waterworks that were useful for all participants, with the expenses to be proportionally defrayed by the grantees.

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The laws effectively applied in the island between 1853 and 1886 attempted to facilitate and promote the construction of water works for irrigation systems, hydraulic force and public use. At the same time, these laws set the guidelines to properly organize and tame the race between public and the private interests for the water sources.

VI. Water Rights as a Source of Power and Struggle

The 1879 *Ley de Aguas*, with its fifteen chapters and two hundred and fifty-eight articles, along with the 1866 law, were a model of jurisprudence. These laws were methodically structured to judicially control and defined everything related to the use of the precious liquid. However, the race to acquire water sources was not guided by a jurisprudential logic, but by a very capitalistic sense of economic survival and class interests.

A quick look at the Serrallés’ family development helps to contextualize the previous statement. Coming from his native Babur (a province of Catalonia), the founder of the southern dynasty, Sebastian Serrallés, arrived in Ponce at the beginning of the 19th century, establishing *Teresa*, a sugar hacienda. In 1859, Serrallés returned to Spain⁵⁶, and after his death, the estate was inherited by his children. In 1861, Juan Serrallés, bought his brother’ shares, becoming the sole owner of *Teresa* and the recently established sugar estate *Hacienda Mercedita*.

Mercedita started with 300 acres located between Ponce and Juana Diaz. Its workforce consisted of slaves and free laborers, at least until 1873, when the slavery system was officially abolished. Its first harvest in 1862 was a success, producing 725,666 pounds of crude sugar. *Mercedita*’s development, however, coincided with the period when the prices of sugar in the international market began a declining process, plummeting dangerously fast during the 1880s, due to the constant rise of the beet sugar industry in Europe. By 1860, 20% of the world sugar production came from the beet. In 1890, that number jumped to 59%.

To face that challenge, Serrallés made significant improvements like mechanizing the most relevant steps in the sugar production process and also mechanizing the transportation

⁵⁶ Estela Cifre de Loubriel, *La formación del pueblo puertorriqueño. La contribución de los catalanes, baleáricos y*

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system in his farms, substituting the traditional oxcart by portable railroad lines and train wagons. However, Serrallés most significant action to fight the prices decline was to grow and expand. Between 1862 and 1892, the landlord acquired twelve sugar production units mostly in Ponce, Juana Díaz and Santa Isabel.⁵⁷

This expansion was only possible through Serrallés' continuous acquisition and control of water sources. As previously mentioned, in February 1844, we found Serrallés been granted water rights from the Inabón River at a rate of 37.69 liters per second for *Laurel*. His father, Sebastian Serrallés, was authorized 42.54 liters p/s from the Inabón for *Teresa* on December 1847, hacienda which eventually became Juan Serrallés' property. Also on December 1847, Juan Serrallés obtained 49.53 l/p/s from the same river for *Fe*. Another concession was granted on November 1872 from the Inabón for *Mercedita, Laurel, Fe, Paraiso, Ponce* and *Ponceña*. Few months before, on August 1872, Serrallés was granted the waters from a stream known as Los Torres to irrigate *Teresa, Coto* and *Mercedita*, and also from quebrada Coto to irrigate *Fe*. He also obtained the rights to draw the winter, spring and torrential waters from the same stream (Coto) on February 1873. By July 1878, Serrallés had expanded to Juana Diaz as he was drawing water from Jacaguas River for his estate *Cintrona*. In 1895, he was taking water from Guayo River in Juana Diaz for *Mercedita* and *Fe* and by October 1896, he was authorized to extract more water from the Jacaguas River for another sugarcane hacienda in Juana Diaz, *Ursula*. During the 1870s, the sugar baron made an incursion in the coffee production acquiring *Hacienda Purgatorio* in Utuado, for which he was granted 11 liters per second from Jauca River to irrigate his 16 hectares coffee farm.⁵⁸

Accessing water sources was a vital tool for economic survival, especially among the southern barons. Controlling those water sources was a vital tool to access power. It was also a powerful mean to eliminate the competition. In 1892, we found Serrallés opposing the request for a concession submitted by Temistocles Laguna to use water from the Inabón for

valencianos. San Juan: Instituto de Cultura Puertorriqueña, 1975, 288.

⁵⁷ Andrés Ramos Mattei, *Los libros de cuenta de la Hacienda Mercedita. Apuntes para el estudio de la transición hacia el sistema de centrales en la industria azucarera de Puerto Rico*. CEREP: san Juan, Puerto Rico, 1975.

⁵⁸ AGPR. Fondo: Obras Públicas. Serie: Aguas. Legajo 190. Expediente 2. Caja 465. Concesiones de aguas hechas en la isla de Puerto Rico durante el gobierno español y el gobierno americano (Para riegos). 1907

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his farm. That very same year, Serrallés joined Juan Roubert, owner of *Ana Maria* and Pedro Salazar, representing the owners of *Mallorquina*, to oppose Mayol Hermanos & Cia's petition to take water from Inabón to move a hydraulic wheel in their coffee farm.⁵⁹ Inabón River was an indispensable lifeline that the early concessionaries didn't want to share with the late arrivals.

Control of water sources by the sugar landlords many times verged on an abuse of power. In 1884, in a letter to the central government, the mayor of Juana Díaz complained that Juan Cortada, merchant and landlord from Ponce, after obtaining a concession to deviate water from Descalabrado River, built "a strong and voluminous masonry dam" that don't allowed "one single drop of the liquid" to run down the river bed. The situation was detrimental to the regular folks living downriver, on which waters they depended for their basic needs.⁶⁰ Cortada's concession dated from August 27, 1868. Granted under the recently approved 1866 *Ley de Aguas*, it was given with the condition that the landlord had to build wells and drinking troughs in predetermined spots for the general population downriver. As indicated by the mayor, sixteen years later (1884) the wells or the troughs were not existent. From his 1868 concession until the very end of the 19th century, Cortada was the sole grantee of the Descalabrado River, allowing him a substantial decisional power in the region.

In other instances, the monopolization of the water sources by the sugar landlords had a tremendous social impact. Santa Isabel provides a good example. Mentioned by Abbad y Lasierra in 1778 as a southern ward of Coamo, by 1841, Santa Isabel became a separate municipality. Among the founders were Francisco Descartes, José María Colón, Gil Capó, Manuel Bernal, Santiago Delpín, Pedro Delpín, Gaspar Alomar and Francisco Famanía, the very same names that eventually became the local landlord elite.⁶¹ Twelve years after its formation (1853), a population and property census done in Santa Isabel showed a very slow development in the town urban core with scarcely 23 wooden houses, belonging to the town's

⁵⁹ AGPR. Fondo: Obras Públicas. Serie: Aguas. Subserie: Sistema de Riego. Caja 424. Legajos 62, 63.

⁶⁰ AGPR. Fondo: Obras Públicas. Serie: Aguas. Caja 465. Legajo 190. Expediente 1106.

⁶¹ Julio Molina Olivieri, *Santa Isabel. Notas para su historia*. San Juan, 1986, 14.

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farm owners: Famanía, Santiago Delpín, José Alomar, Juan José Cabrera, among others.⁶² When in the late 1870s, Manuel Ubeda y Delgado published his significant research, Santa Isabel showed an increase in population in the urban center, but a significant decrease in the urban property value, been less that the one estimated in 1853.⁶³

This apparently contradiction between an increase in population and a decrease in property value, reflected the social fabric of Santa Isabel. Contrary to its immediate neighbors like Ponce, Coamo or Guayama, whose urban centers were dominated in every way by the economic power and social predominance of the upper classes, Santa Isabel's urban center, scarcely thirty years after its formal foundation, was dominated by the presence of the working class. This social condition could had only been caused by an earlier process of land accumulation among few hands and a loss of means of production among the local workers. In other words, the local small farmers seen to have lost their capacity for accessing land, losing their ability to sustain themselves through their own means and having no other choice than to become a rural proletariat. With the urban center outskirts surrounded by estancias and sugarcane haciendas, the newly formed rural workers moved directly into the urban core, been the closest area to the production centers.

The physical and social displacement of the small farmers in Santa Isabel was a direct consequence of the town landlord's elite effectiveness in controlling the water sources, precisely at the time when Santa Isabel was initiating its political life as an autonomous municipality. By 1849, Buenaventura Torres, with 2000 *cuerdas*, Antonio Velez, with 1,000 *cuerdas*, José Alomar, with 816 *cuerdas*, Pedro Juan Capó, with 732 *cuerdas*, among others, were taking the waters from the Coamo River, the nearest water source to town. Each one was responsible for building their own canals. It seems, however, that dams and water intakes were shared and the water later diverted through separate canals to each one of the sugar estates and estancias (**Fig. 3**). An around the clock system was work-out. On a monthly basis, Torres was allowed 13 days, 4 hours and 37 minutes of water; Velez, 6 days, 14 hours and 18

⁶² AGPR. Fondo: Gobernadores Españoles. Serie: Santa Isabel. Caja 583.

⁶³ Manuel Ubeda y Delgado, *Isla de Puerto Rico. Estudio histórico, geográfico y estadístico de la misma*. Puerto Rico. Establecimiento tip. Del Boletín, 1878, 245-246.

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minutes; Alomar, 5 days, 9 hours and 10 minutes, and so on.⁶⁴ A person, with the title of *Maestro de Fortificación*, was designated to over watch the amount of water taken and the proper time-keeping.



Figure 3. Partial view of a late 1800s dam, water intake and supply canal, built on the Coamo River to provide water for three haciendas: *Florida*, *Santa Isabel* and *El Destino*. (Photographer: Juan Llanes Santos, 2016)

Complaints were submitted by local farmers explaining that the reduced amount of water in the Coamo River was affecting their small crops and their ability in using the water for their basic needs. As the conditions worsened, the small farmers moved to the urban center, leaving the lands available for the hungry landlords. Now, as rural workers and urban dwellers, the small farmer became the labor force of the very same economic forces that displaced them.

The way the landlords from Santa Isabel organized themselves served as a model for other sugar barons, substituting cooperation for competition. In 1883, for example, Juan Serrallés and José Gallart were granted authorization to build a dam across Guayo River in Juana Díaz. The masonry dam was sixteen meters long, three meters high from the river’s

⁶⁴ AGPR. Fondo: Obras Públicas. Serie: Santa Isabel. Caja 343. Año, 1849.

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foundation and one meter wide. The structure stood 0.40 meters above the river's surface, so the water could easily go over the dam during floods. Near the eastern bank, a partitioning wall divided the current towards Gallart's *Tres Hermanos* and Serrallé's *Ponceña's* canals. Each masonry water intake had a one meter wide sluice, with sides been 0.40 meter high (**Fig. 4**). Gallart's water intake directed the current right into a masonry canal built alongside the eastern bank, while Serrallé's guided the waters back into the river's current. La *Ponceña's* intake was located about four hundred and fifty meters downriver, as part of another masonry dam already built.⁶⁵

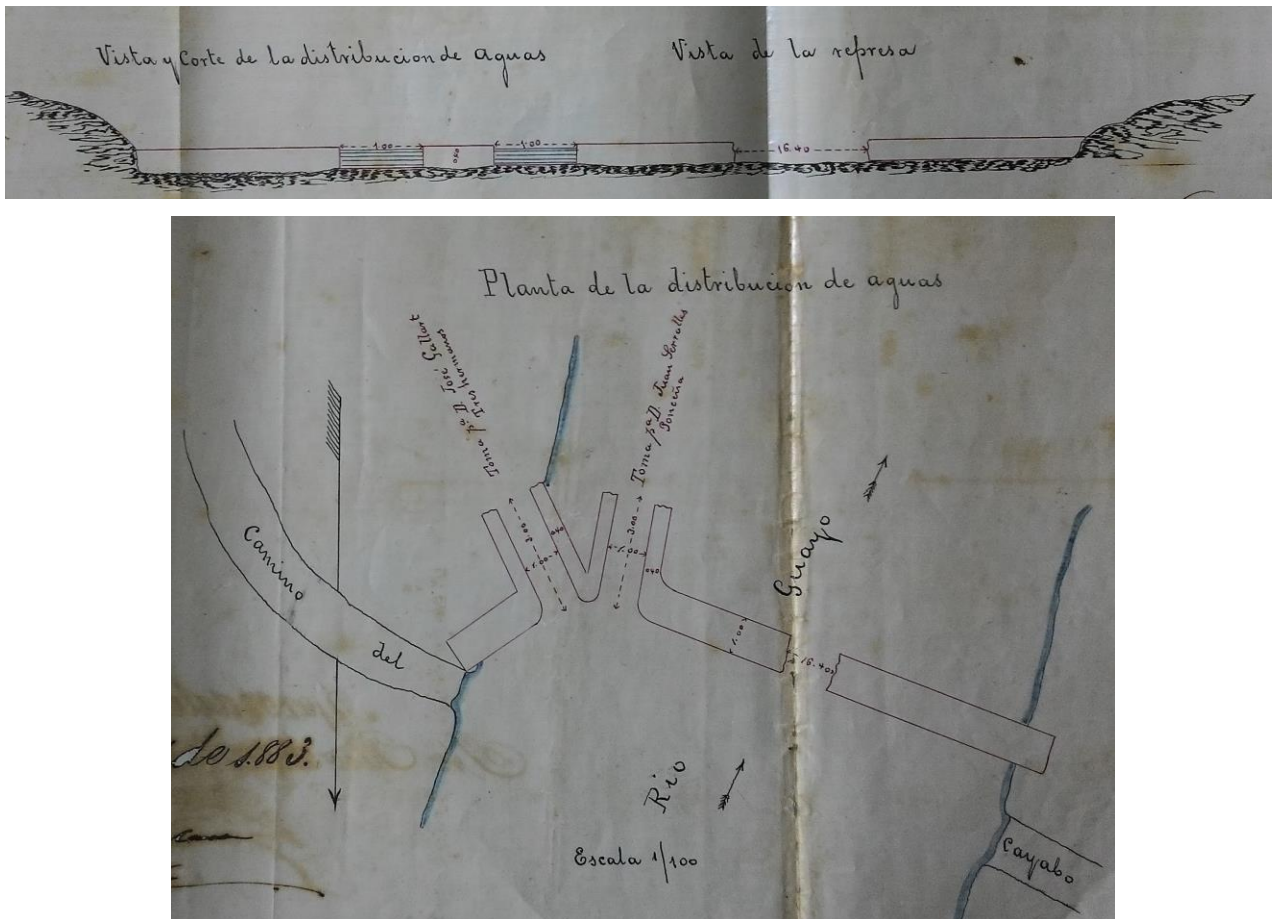


Figure 4. The 1883 plan for Gallart and Serrallé's dam across Guayo River, Juana Díaz.

⁶⁵ AGPR. Fondo: Obras Públicas. Serie: Aguas. Caja 420. Legajo 796.

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Sometimes, even the law's dispositions served the monopolistic purposes of the sugar barons. That was the case of the entity defined as the *Comunidad de Regantes*. As explained before, the 1866 *Ley de Aguas* required that once more than twenty concessionaries were drawing water from the same source, this legal body was to be formed, and among its members, a Syndicate was to be elected to direct all things related to the water rights. In some instances, the *Comunidad* became an established force, reluctant to changes and to accept new members. The early grantees used it to keep away new concessionaries and their construction projects.

The *Comunidad de Regantes* formed to manage the waters from Jacaguas River in Juana Diaz is a good example. Initially, the early grantees had to be forced by the municipality's authorities to establish the *Comunidad*, sometimes even assuming an authoritarian stand among the irrigators. In 1858, for example, due to a serious drought, Juana Diaz's Mayor tried to bring together all the landlords using Jacaguas to work an agenda to distribute the scarce waters. Some of the sugar barons agreed, but most of them opposed the government's interference and argued that the concessions granted should determine the amount of water to be taken. Some went as far as to recommend a seniority schedule, indicating that the water should be distributed first among the early grantees.⁶⁶ However, once the *Comunidad* was formed, the landlords quickly adapted it to their interests, becoming a force to be reckoned with. By the early 1870s, Jacaguas River was one of the most regulated rivers in the southern region, becoming the lifeline of a powerful group of sugar estates from the early 1840s: *Potala*, *Amelia*, *Ursula*, *Fortuna*, *Unión*, *Bocachica*, *Placeres*, among a few others.

Two separate incidents show the use of the *Comunidad* by these southern landlords as a tool to protect their collective interests. In 1877, the *Comunidad* brought charges against the influential sugar baron Juan Serrallés for the illegal use of waters from Jacaguas. Apparently, during the previous four years, Serrallés had been using the river without a concession to move a steam engine in *Destierro*, his sugar estate in Juana Diaz. Using the legal dispositions

⁶⁶ AGPR. Fondo: Obras Públicas. Serie: Aguas. Subserie: Sistema de Riegos. Caja 434. Legajo 1002.

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provided by the 1886 *Ley de Aguas*, the *Comunidad* imposed a two hundred pesetas fine and ordered the demolition of the water intake and its canal.⁶⁷

During the early 1870s, the *Comunidad* also faced the powerful landlord and merchant Juan Cortada in a fight for the Jacaguas River. By 1869, Cortada was already the sole grantee of the waters from Descalabrado River, from which he was authorized to draw 165 liters per second to irrigate his sugar estate *Descalabrado*. In 1870, Cortada requested to take an additional 200 liters per second from Jacaguas. The landlord claimed he was just actually getting 100 liters from Descalabrado, due to his low level, and he needed additional water to irrigate the land on which so much capital was invested. The extraction of water from Jacaguas River to Cortada's estate would it required the construction of a canal irrigation system of over nine kilometers in length. Once Cortada's request was publicly announced, Jacaguas' *Comunidad de Regantes* immediately expressed their opposition, especially those whose haciendas were located down river from Cortada's planned intake (**Fig. 5**). These owners claimed that the proposed dam was so strongly fortified that would adversely affect the river's current. Shortly thereafter, the upriver landlords also opposed the plan, supporting their down river brethren.

For over a year, an interesting and facts-revealing legal battle took hold among the contenders. Cortada contracted the services of engineers and surveyors to show that Jacaguas carried enough water to support everybody's claims, while arguing that the actual grantees were taking more water than it was allowed to them. He suggested the installation of water modules on everyone's intakes to control and account for the flowrate; a suggestion described as unnecessary by the *Comunidad*. The *Comunidad de Regantes* was able to bring the municipal officials to their side. Juana Diaz's representatives claimed jurisdiction over the Jacaguas River, and opposed Cortada's request to transport its water over to another municipality, as *Descalabrado* was physically located in Santa Isabel. They described this request as detrimental to the population that used Jacaguas for their basic needs, and equally negative to Juana Diaz's landlords, whose payments on their property taxes supported the

⁶⁷ AGPR. Fondo: Obras Públicas. Serie: Aguas. Caja 433. Legajo 77. Expediente 23.

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municipality' social efforts.⁶⁸ Eventually, the *Comunidad* won the battle and kept Juan Cortada out of Jacaguas River.

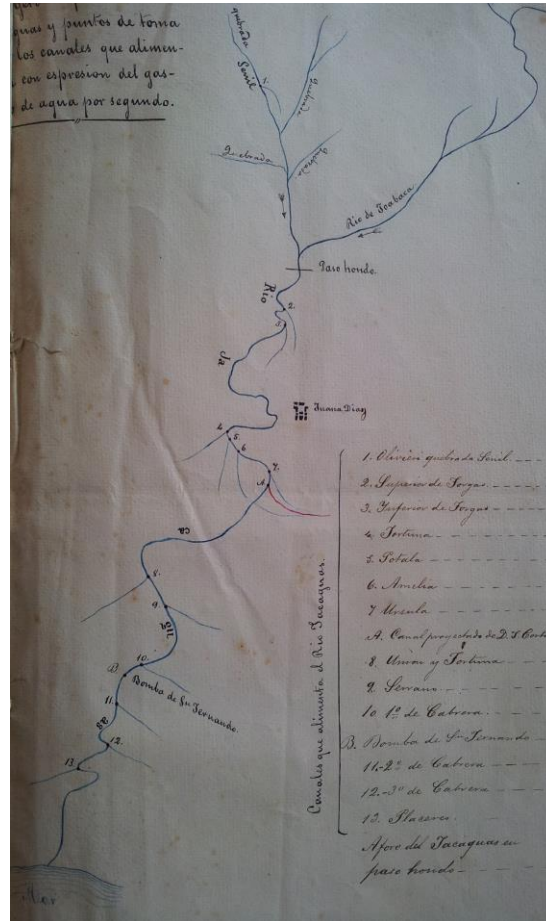


Figure 5. An 1871 Jacaguas' schematic showing grantees and location of the water intakes. The red line was the intake proposed by Cortada.

Even with the effectiveness shown by the organized power within the *Comunidad de Regantes*, it took many more years to actually elect a Syndicate for Jacaguas River. By just not showing, Juana Diaz's landlords sabotaged the possibility of creating the Syndicate every time a meeting was called for that purpose. The lack of quorum prevented its formation. Apparently, they considered the *Comunidad de Regantes* an excellent tool to stop the inclusion of new concessions, but disliked the creation of the Syndicate, as this entity's purpose was to regulate the existing grantees. In 1874, the general government authorized

⁶⁸ AGPR. Fondo: Obras Públicas. Serie: Aguas. Caja 433. Legajo 78. Expedientes 455, 1009.

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Juana Diaz's officials to actually impose a fifty pesos fine upon the landlords that didn't showed up when a meeting was called.

The lack of a Syndicate allowed the abuse of power of some landlords upon others. This real hardship came up in a letter submitted by three Jacaguas' grantees on December 1875. Giusti Cabrera, D. Palmieri and Clemente de Fleurian called the attention to the authorities of the need of establishing the Syndicate and in applying the already approved order to install the flowrate modules on everybody's water intakes, as it was indicated in the decree of September 12, 1873. The landlords claimed to have loose two thirds of that year crops due to the drought, but mostly by the abusive, selfish cornering of the waters by the upriver grantees.⁶⁹

A similar situation can be found in other municipalities. In January 1871, the Valdivieso Family, owner of the sugar estate *Dolores* in Peñuelas made a formal complaint before the municipal authorities, indicating that some landowners upriver (Tallaboa River) were taking more water than the volume granted, some had no flowrate modules installed as required, while others had water intakes and irrigation systems build without even having a legal concession. The Valdivieso explained that, although they had two water grants, one dating from November 16, 1847 and the other from December 4, 1852, and even after building "a very expensive dam" in 1870, there was still not enough water, not because of any drought, but for the improper use of the river. In the letter, the Valdivieso included the names of the alleged violators. Eventually, a representative of the *Jefatura de Obras Públicas*, made a detail onsite inspection finding many irregularities. The owners of the sugar estate *Pepita*, were fined a 1000 pesetas for illegal construction; Luis Costas was fined 625 pesetas for illegal construction and purposely damaging a flowrate module; José Rodriguez Soler was sanctioned for improper use of the water taken as the water surplus was not returned to the riverbed as required; landlord Simón Brun was found guilty of taking an excessive amount of water. However, the penalties imposed seen to have little effect. In 1873, the Valdiviesos were again informing the municipal authorities the imminent loss of their crop due to a drought, but

⁶⁹ AGPR. Fondo: Obras Públicas. Serie: Aguas. Caja 428. Legajo 71. Expediente 976.

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mostly due to the improper use of the Tallaboa River by their upriver neighbors.⁷⁰ As the last resort, the *Jefaturas de Obras Públicas* suggested the possibility of assigning to Tallaboa a guard to monitor water intakes and the integrity of the flowrate modules, having the grantees to pay the porter's wages.⁷¹ Been just a suggestion, this more than likely remained a wishful thinking.

VII. Looking at Some of the Waterworks

When 20th century observers comment about the quality of the waterworks built during the 19th century, especially irrigation systems, the adjectives more frequently used are "primitive", "simple", "elemental" or "rudimentary".⁷² If compared to the irrigation systems, or other water works, built in the island during the first three decades of the 20th century, those adjectives might be considered appropriate.⁷³ However, every resource should be evaluated within their own historic context.

In order to get at least a basic idea of the type of waterworks undertaking, it's necessary to look at some of the concessions granted during the last six decades of the 19th century. During the early 1840s, the solicitations for water rights were accompanied by a very succinct documentation. In some instances, the very same landlords indicated the absence of qualified personnel in the island to properly organized, planned and built the needed irrigation systems. However, as the years passed, as the implanted laws required a more detail explanations of the undertakings and as a cadre of trained engineers and surveyors develop, the irrigation, the water power and the aqueducts systems became more ambitious in their scope, extension and complexity.

⁷⁰ AGPR. Fondo: Obras Públicas. Serie: Aguas. Caja 461. Legajo 177. Expediente 1272.

⁷¹ Ibid. Legajo 178. Expediente 14.

⁷² Report of the Governor of Porto Rico to the Secretary of War, 1913, 58. Washignton Government Printing Office. Describing the actions of the land owners of the 19th century in dealing with the southern climate, it was mentioned that "for years they made use of primitive methods of irrigation". Rafael Picó, makes the same statement affirming that to deal with the 19th century droughts, in the southern region "primitive irrigation systems were used", see, *Nueva geografía de Puerto Rico. Física, económica y social*, 86. Historian Francisco A. Scarano also mentions that during the 1840s, the southern haciendas "built rudimentary irrigation canals"; see, *Haciendas y barracones: azúcar y esclavitud en Ponce, Puerto Rico 1800-1850*, 81.

⁷³ The present work is the first of a two parts thematic. A subsequent theme will cover waterworks in Puerto Rico

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Many projects had a local impact, but their development is illustrative. In 1897, for example, Mari Hermanos, owners of the coffee-growing *Hacienda Desideria* in San Germán, received approval to build a dam, a water intake and a supply or piping canal to conduct 125 liters of water per second from the Hoconuco River into their coffee factory. The water was to be used as an engine to move a six meters in diameter wooden wheel, which in turn was to move the equipment to peel-off and polish the coffee seeds.

The dam was slightly over 9 meters in length, in solid masonry faced with hydraulic mortar, placed at the narrowest point across the entire river. The location was not only chosen for its narrowness, but also because the western bank of the river had a prominent rock formation that was to be used as a dam's buttress. The narrow straight also made possible to keep the dam's height to just 1.75 meters from top to bottom. To add sturdiness to the dam, it combined a rectangular shape at the top length, with a trapezoidal section at the bottom. The diverted water was channelized through gravity to the coffee factory in a three hundred and eleven meters long, masonry built canal. Once the obtained water accomplished its purpose as hydraulic force, it was diverted back to the river through a trench cut in the natural ground **(Fig. 6)**.⁷⁴

from 1908-1960.

⁷⁴ AGPR. Fondo: Obras Públicas. Serie: Aguas. Caja 420. Legajo 54. Proyecto de una presa para aprovechar las aguas del Río Hoconuco.

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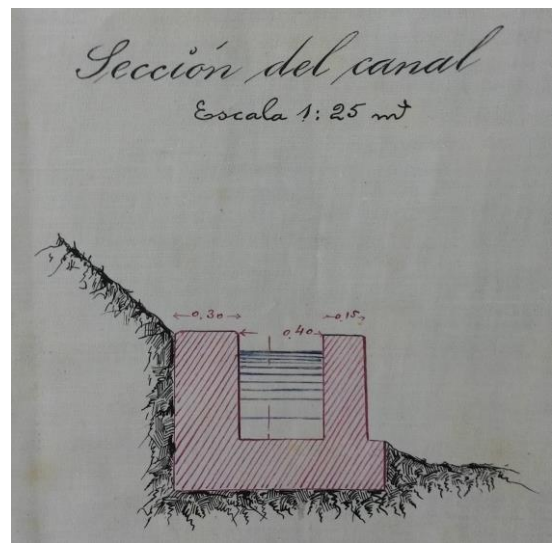
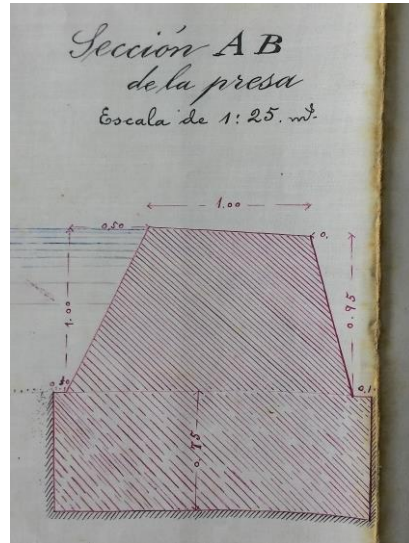
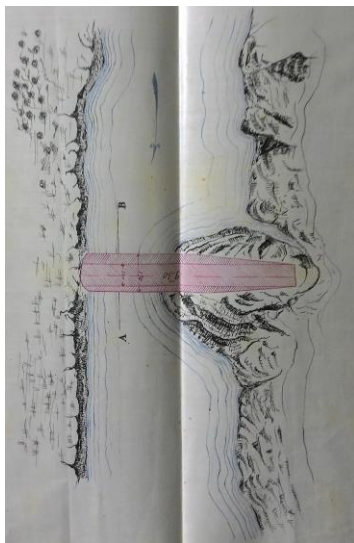


Figure 6. Above, *Desideria's* general plan, showing the dam, canal (in red), coffee factory and drainage trench. Below, details of the dam, a dam's transversal view and a section of the masonry canal with height and width.

The so called simplicity of these 19th century waterworks become less sustainable when a close reading of the construction's memorial narratives is conducted. Prior to construct *Desideria's* system, precise mathematical calculations were used to determine the needed thickness of the dam, which depended in the determination of the amount of water (*aforo*) carried by the river in a cubic meter and the speed of the current with water at normal levels

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(*aguas estiales*). Another determining factor was a calculated mathematical extrapolation to account of how much water was the river to carry in case of a flood, and how high, in meters, would the river rise.

For a 311 meters-long canal, as the one planned and built for *Desideria*, out of the 125 liters of water per second taken from the river, a minimum of 100 liters had to reach its final destination in order to properly move the six meters-in-diameter wooden wheel. The quality and type of ground in which the supply canal was to be laid-out had to be analyzed to determine its absorption capacity, as only 25 liters of water could be lost due to filtration. If the absorption/filtration rate of the ground was to exceed the maximum loss allowed, then the canal's bottom had to be filled with tamped-down pebbles (*chinos de río*), which still allows a certain filtration or plastered with hydraulic mortar, which prevented most filtration. For *Desideria*, it was determined that the entire 311 meters supply canal was to be made of solid masonry, plastered with hydraulic mortar.

The width and height of the supply canal walls, along with the canal's incline, had to be mathematically calculated as well, as these factors affected the speed of the water running through the canal. The water had to hit the wooden wheel at a certain speed to have it move at the industrially needed velocity, so the wheel could generate its five-horsepower capacity.

This process, which involved field research and analytical and methodical estimates before the actual construction, was part of any type of waterworks regardless if its purpose was for irrigation, hydraulic force or water supply.

In the paperwork submitted by *Desideria*, expenses were itemized, as these represented the requested tax exemption: the masonry used at the water-intakes and the wooden gates, 3,000 *escudos*⁷⁵ ; the construction of the 563 lineal meters of the vaulted canals, the culverts, excavation and ground preparation, 22,438 *escudos*; the 520 lineal meters of open-ditch-masonry sheathed canals, 8,320 *escudos*; and 5,392 *escudos* for the 1,348 lineal meters of open trenches in the natural ground. The exempted amount reported

⁷⁵ The *escudo* was Spain's currency until 1869. It replaced the *real* at a rate of 10 *reales* = 1 *escudo*. The *escudo* was replaced by the *peseta* in 1869, when Spain joined the Latin Monetary Union.

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was a total of 39,150 *escudos*.⁷⁶

Some of the submitted requests included valuable information in the use of specialized build section and equipment or mechanical parts that were essential components of the waterworks. In late 1894, for example, Manuel Rosaly, a landlord from Ponce, requested a concession to draw sixty liters of water per second from the Inabón River to move a hydraulic wheel on his 379 *cuerdas* coffee-growing hacienda *Anón*. From the intake, the water was to be transported by gravity to the factory in a three hundred and fifty meter-long masonry canal. Once the water was used, it was to be returned to the Inabón by an open ditch on the natural ground (**Fig. 7**). In March 1895, after all paperwork was submitted, the project publically announced and the thirty day waiting period for oppositions were over, the request was approved. By August 1895, personnel from the *Jefatura de Obras Públicas* inspected and accepted the work done at *Anón*.

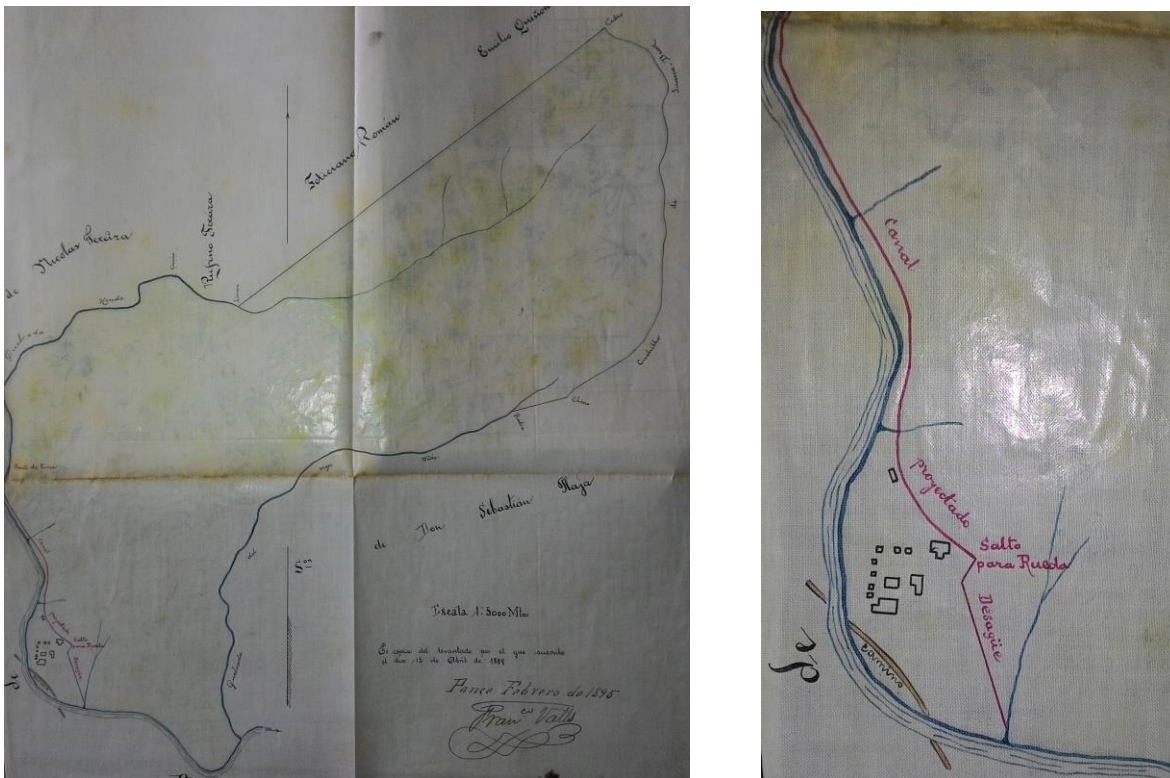


Figure 7. Left, *Anón*'s 379 *cuerdas*. Right, detail of the 1895 water work project.

⁷⁶ AGPR. Fondo: Obras Públicas. Serie: Aguas. Caja 464. Legajo 186. Expediente 546.

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To deviate the water into the canal, a dam was diagonally built across the river. The dam was made of tightly-pack-loose rocks (term used to differentiated these from the solid masonry dams), which allowed the current to follow its path by filtration, and didn't raise the water level significantly. Because the river's eastern bank grading was lower than the western side, a support masonry wall was built on the eastside to prevent the water from spilling and help into guiding it into the intake (**Fig. 8**).

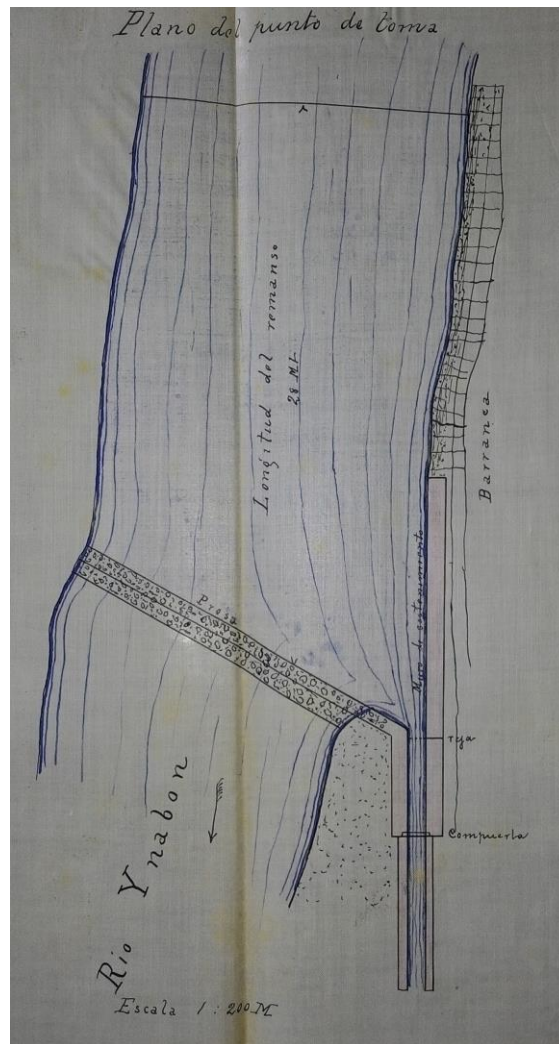


Figure 8. View of Anón's dam and water intake.

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The intake built in *Anón* was a specific design called a water module. It was configured to control the integrity, speed and amount of water. At the entry sluice an iron grill (*reja*) was placed to stop large debris for entering into the supply canal. This first section of the module was wider and with thicker sidewalls to handle and slow down the initial rush of water. This section ended precisely at an iron gate (*compuerta*) bolted down into the canal masonry frame. The gate was manually operated to lower or raise an iron plank, controlling the water input (**Fig. 9**).⁷⁷

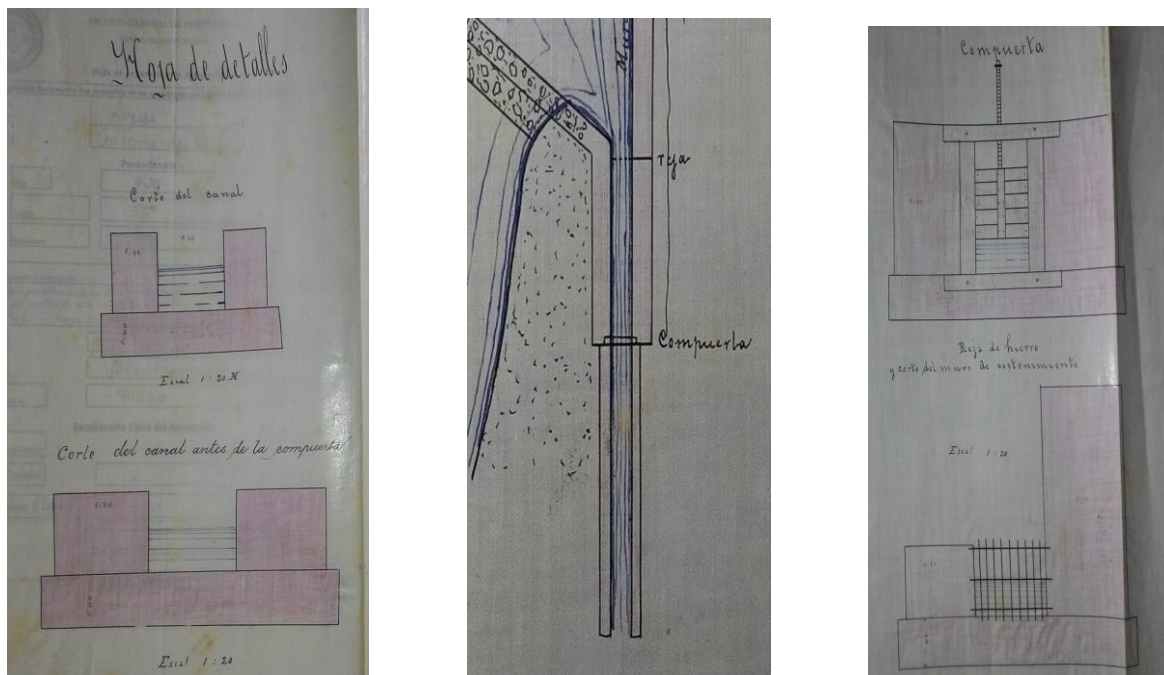


Figure 9. Details of the schematic of the canal section at the module (left), the water module system (center) and the schematic for the iron gate and grill to be used.

Earlier works than the ones done at *Desideria* or *Anón*, showed also a complex combination of material, design and functionality. One such example is the irrigation system developed by the owners of the sugarcane *Hacienda Buena Vista* in the municipality of Guayanilla. In 1844, a water concession was granted to *Buena Vista* to deviate the currents from two different *quebradas*, el *Cedro* and *Macaná*. Various types of canals were prepared in

⁷⁷ AGPR. Fondo: Obras Públicas. Serie: Aguas. Caja 420. Legajo 55.

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order to get the water from the streams to the fields. The canal coming from el *Cedro* combined three different types of construction techniques in one single system. Initially started as a 636 meters long masonry sheathed open ditch, that connected to a 530 meters long masonry and bricks vaulted canal and later ended as a ground open trench. On the other side, the canal from *Macaná* was 2,095 meters long, consisting of one section of 747 meters masonry-sheathed-ditch, a brick vaulted canal 333 meters long and the rest, an open trench in the natural ground. The vaulted sections of the irrigation system were 0.65 meters in height and 0.55 meters wide. At the water intakes, two wooden gates were placed to regulate the amount of water taken. *Buena Vista* used the waters to irrigate 155 *cuerdas*, equivalent to 41 hectares (**Fig. 10**).

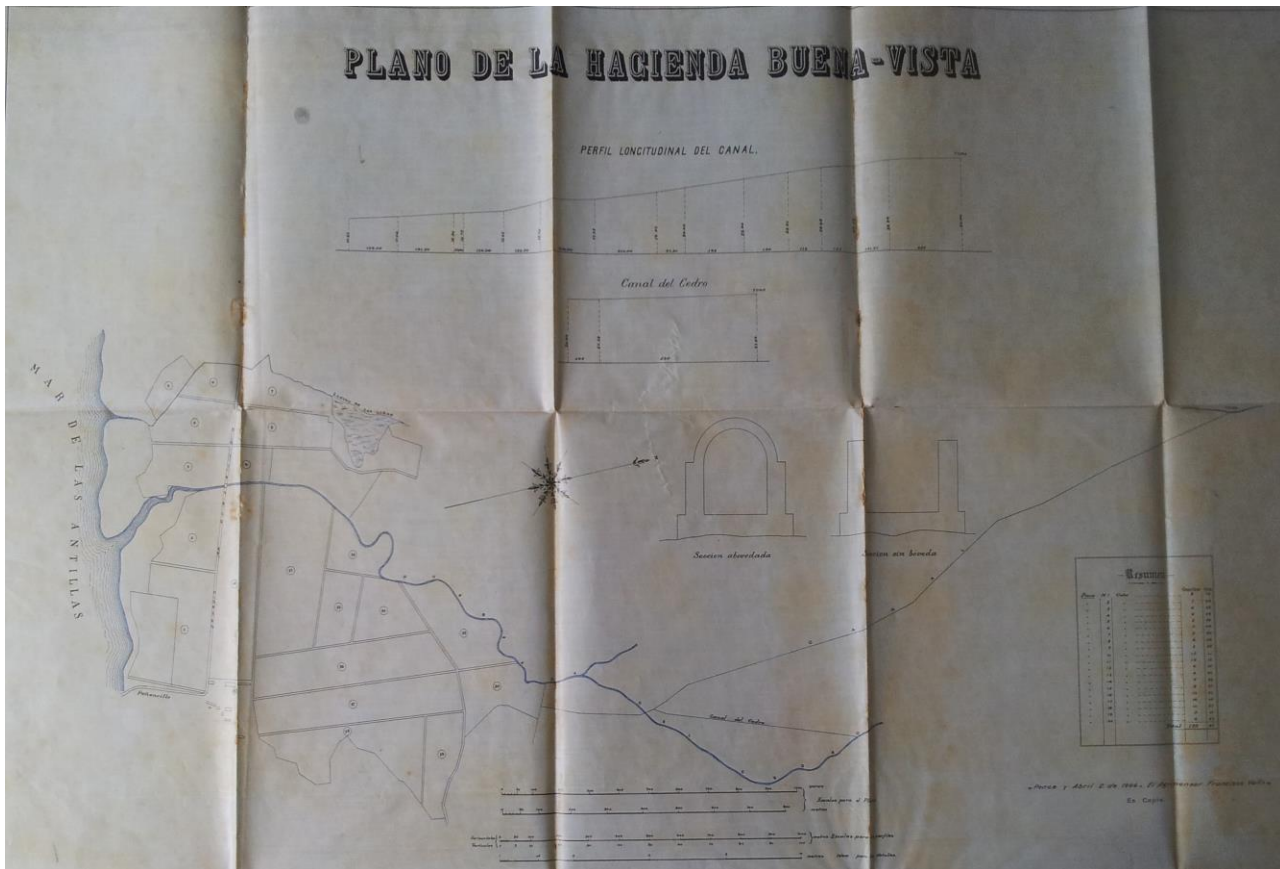


Figure 10. The 1866's *Buena Vista*'s general plan, depicting the sugarcane fields, the irrigation canals and drawings of the vaulted and open sections of the masonry canals.

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Another illustrative example of the type and kind of waterworks accomplished during the 19th century is the irrigation system developed by Juan Cortada. As it's already been mentioned, by 1870, Cortada became master of the Descalabrado River, exercising a monopolistic control upon its waters. On August 27, 1868, immediately after acquiring the sugar estate *Descalabrado* from Mrs. Soledad Renta, Cortada obtained the approval to draw 165 liters of water per second to irrigate 600 out of total 1038 *cuerdas* in the estate. The northern lands of the hacienda, farther away from the saline sands of the Caribbean, were the most productive grounds in *Descalabrado*. In December 1868, Cortada added 300 *cuerdas* to *Descalabrado*, buying-out Esteban Canevaro, his northern landlord neighbor. Because this addition, Cortada requested to change the water intake already approved from a point called "el charco de la Ceiba", to another location farther north upriver, named "el charco de Miguelo". From *Descalabrado* to "la Ceiba", the projected canal was 2,439 meters long. The requested change added an additional 1,700 meters. With the change of water intake point, it was also included a new route for the canal. The first one, was to run alongside the river's waving eastern bank. The new approach proposed a straighter route, running across private cattle ranches. The June 26, 1869, copy of the *Gaceta de Puerto Rico*, the official newspaper, announced that, finding no objections, the general government approved Cortada's new plan.⁷⁸

Cortada was given eighteen months to complete the undertaking, starting from the date of the new approval (June 1869). The grant came with a number of demands. Among these, Cortada had to build "pozos y abrevaderos" (wells and drinking trough) for those downriver affected by the dam and canal construction. The cattle ranchers on whose lands the canal was to be built were authorize to draw water from it (by hand) and to have their animals drink water from the open sections of the canal. Where in need, the builder was responsible for placing metal or wooden planks over the canal for animal and pedestrian crossings. By March 1870, it was reported the completion of all works.

⁷⁸ AGPR. Fondo: Obras Publicas. Serie: Aguas. Caga 433. Legajo 78. In actuality, contrary to what was reported in the *Gaceta*, there were objections.

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The built dam was of solid masonry, twenty eight meters long, one meter in width, placed diagonally across the entire river. Elevating the river’s water approximately 0.50 meter over their normal levels, the dam forced the current to deviate into the water module. The module had an iron grill to stop the debris, follow by an iron gate manually operated to control the flowrate. For the first twenty meters after the iron gate, the canal was a masonry-all-around open ditch, 0.80 meters wide, with walls 0.60 meters high (**Fig. 11**)

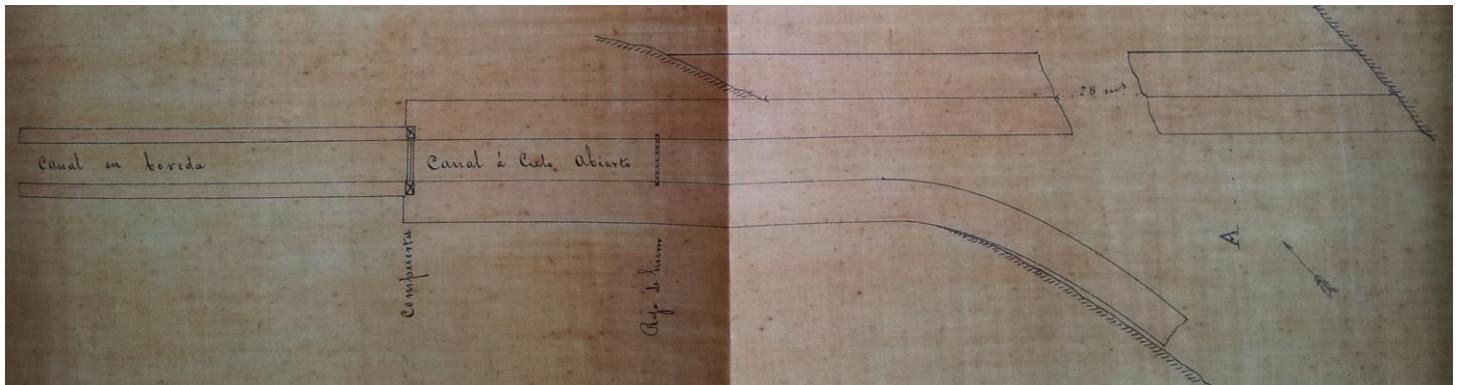


Figure 11. Detail of the plan for Cortadas’s dam and water module.

After the water module, the irrigation canal consisted of a continuous nine hundred meters brick and masonry vaulted section (**Fig. 12**). After this initial 900 meters, until reaching Descalabrado, the rest of the canal was an all-around-masonry open ditch. At certain intervals, the 900 meters vaulted section had openings (*pozos o registros*), that allowed for proper inspection and cleaning.

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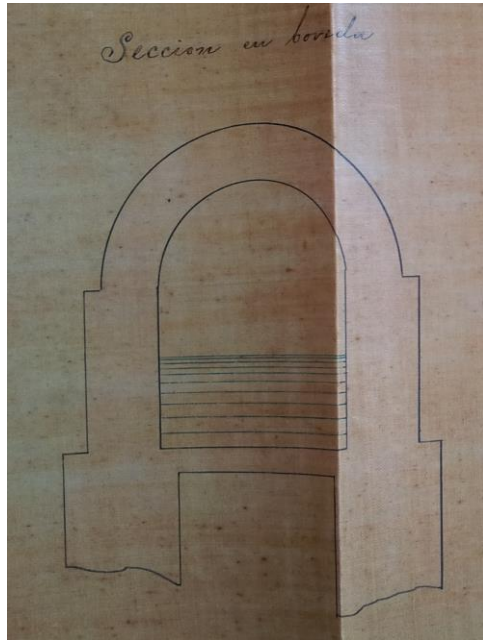


Figure 12. Left, detail of the 1868' schematic of the vaulted section on Cortadas's canal. Right, for comparison purposes, photograph of an existing vaulted section of an irrigation canal built by the joint effort of three haciendas (Florida, Santa Isabel and Destino) during the 1880's in Santa Isabel. (Juan Llanes Santos, photographer, 2016)

As the works grew in size and scope, the complexity increased. The irrigation system built in Guayama by the owners of the sugar estates *Santa Elena* and *Felicidad*, proved that this “primitive works” could become highly complex. In 1860, Domingo Curet, a landlord from Guayama, officially transferred the ownership rights of his sugar estates, *Santa Elena* and *Felicidad*, to his sisters, Catalina Curet de Villodas and Josefina Curet de Bustamante. As described, the haciendas included “an irrigation canal taking the waters from Aguamanil River (today, Guamaní River), from where the river crosses the road from this jurisdiction towards Cayey; the canal crosses this settlement and runs towards the Machete ward, to fertilize *Santa Elena* and *Felicidad*”.⁷⁹ The description does not reflect the canal’s magnitude in size or its impact upon Guayama’s urban core.

⁷⁹ AGPR. Fondo: Obras Publicas. Serie: Aguas. Caja 417. Legajo 41. (Translation is ours)

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The water concession for *Santa Elena* and *Felicidad* was granted on November 6, 1850.⁸⁰ As it was approved prior to the 1866 *Ley de Aguas*, the records didn't show the amount of water granted or the amount of land to be irrigated. The sugar estates were located in the Machete ward, south of the local road that leads from Guayama to Patillas, directly facing the Caribbean. The water intake was placed where the Guamani River crossed the road going from Guayama to Cayey, precisely at a point where the waters seems to form a pond, before continuing their southern course. A wooden gate, made from the very solid wood of the ucar tree, manually operated, was used to control the flowrate. From the water intake, until reaching Guayama's urban center, the canal was an open type, with masonry walls and tamped-down rocks as flooring. As the canal was running on private and public lands, nearby folks were authorized, by law, to draw water from it for their personal use and for their animals, as long as the water was taken by hand, without using any equipment.

Reaching the urban center on its northern corner, the canal went underground, becoming a heavily built vaulted canal. It traversed the town in a southern direction for almost nine blocks, then turning southeast for another five blocks. Once passed the road that led from Guayama to Patillas, the canal came above ground again as a masonry-open type, ending at Santa Elena's northwest boundary. From the water intake, until Santa Elena, the canal ran for 4.53 kilometers (**Fig. 13**).

The *Santa Elena/ Felicidad* canal took several years to complete, but it was all done by 1860. It's logical to assume, that the most difficult section was the underground part through town. The documentation indicates that "*the vaulted part of the canal that runs through the streets of this town has solid dimensions to resist the pressure of the enormous weight that gravitates upon it*". It could also be logical to assume, that remains of the old vaulted canal can still be found in today's Guayama urban center. The mathematical calculations, estimates, the topographical research (that shows in the historic documents), expenses and labor employed, made this undertaking a significant accomplishment that could hardly be describe as simple or rudimentary.

⁸⁰ AGPR. Fondo: Obras Públicas. Serie: Aguas. Caja 465. Legajo 190.

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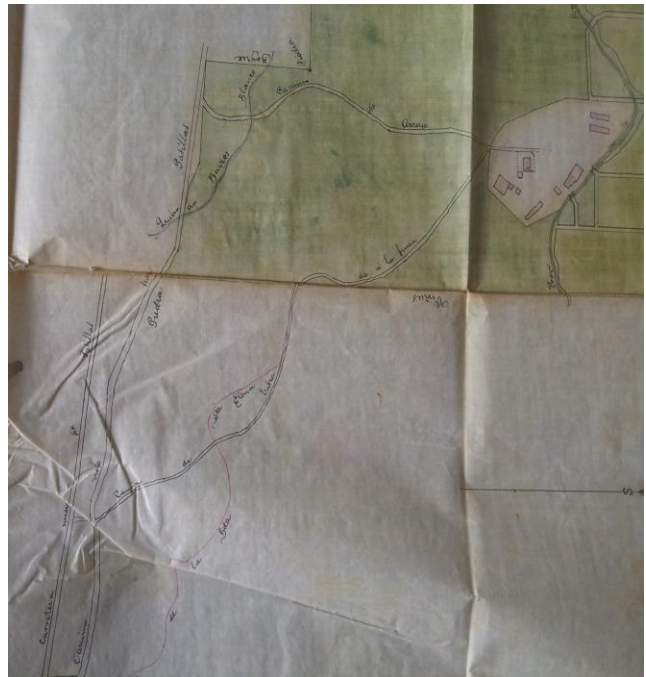
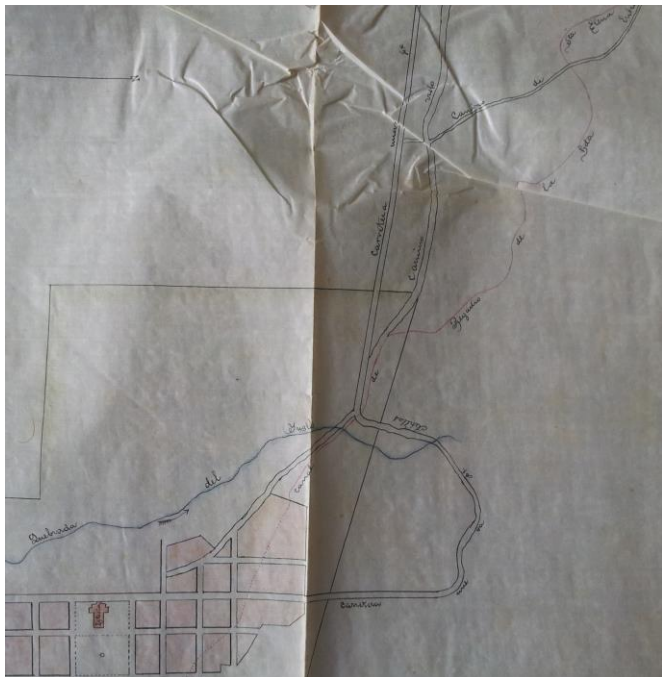
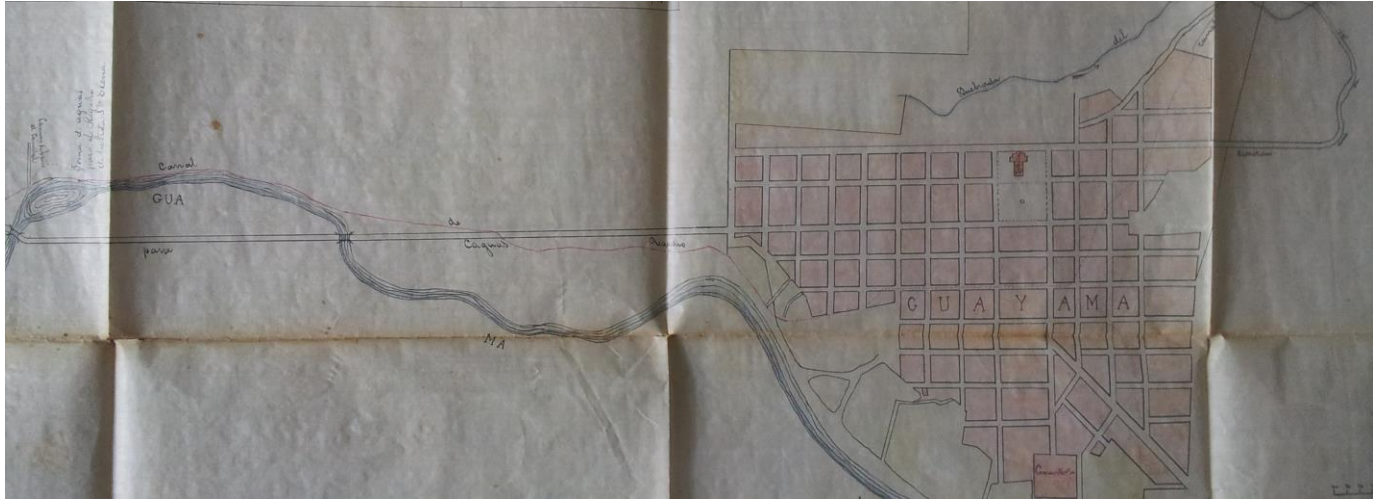


Figure 13. Upper image depicts the canal's route (red line) from the intake until Guayama. Dotted red line marks the underground canal through town. Below, the canal surfaced at the town southeast corner towards Santa Elena.

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The magnitude of the works could also be appreciated when seen collectively. As previously stated, by the 1870s, the waters of Jacaguas River were extremely compromised. Operating under the supervision of a very strong *Comunidad de Regantes*, Jacaguas was the lifeline of a significant number of sugar estates. Hacienda *Luciana* was taking 83 liters per second from Jacaguas; *Cristina*, 51; *Fortuna*, 95; *Potala*, 157; *Amelia*, 87; *Ursula*, 120; *Unión*, 16, *Serrano*, 86; *Placeres*, 29; and *Bocachica*, 163 liters per second. Each one of those water concessions, implied the construction of dams, water modules and canal distribution systems from the river to the cane fields. (Fig. 14).

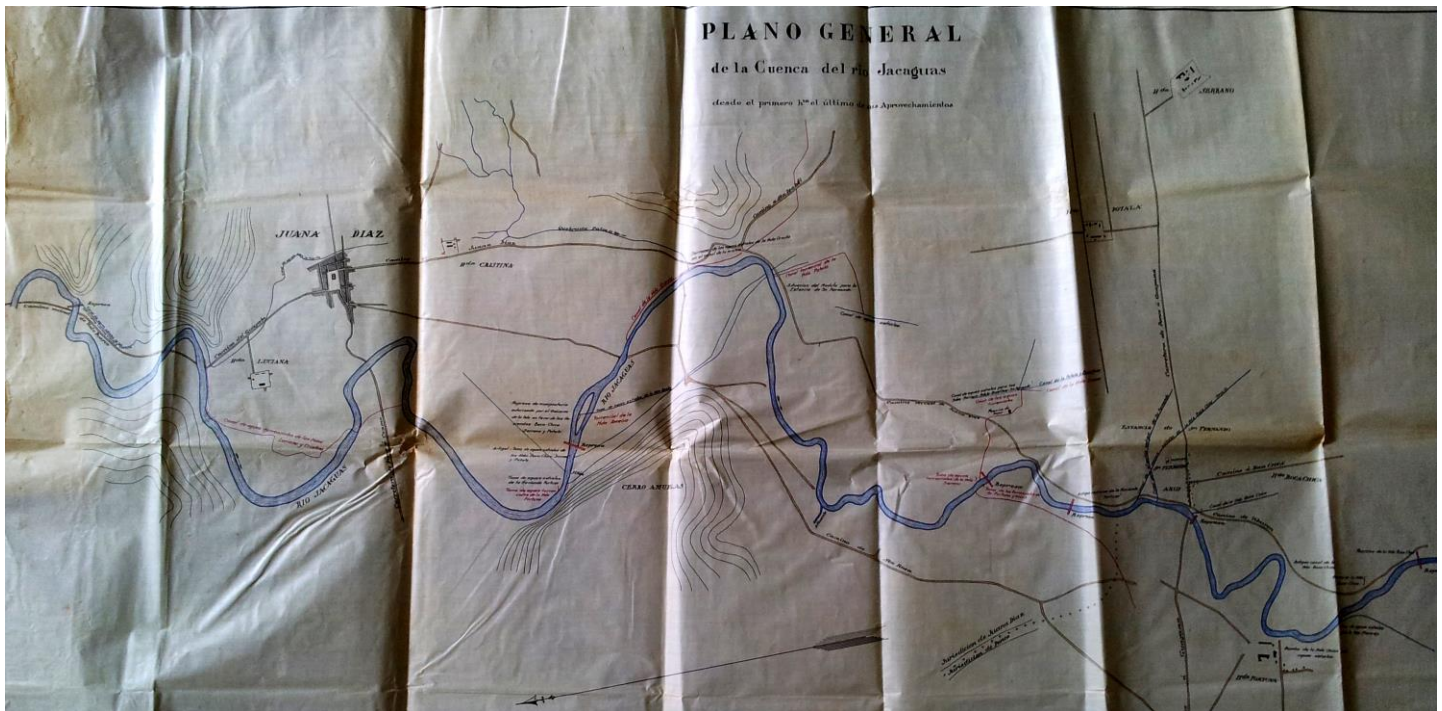


Figure 14. An 1878 plan indicating the location of every dam, water intakes and canal system of major sugar estate in the Jacaguas River.

In some instances, the waterworks included additional assignments, as for example, the *Luciana's* irrigation canal had a deviation to provide water for a public fountain in Juana Diaz's urban center. *Bocachica*, on the other side, had three different water intakes, which translated as three canal systems. By 1878, Jacaguas's current was interrupted by six solid masonry dams. Sometimes, the canal distribution systems was shared by two or more haciendas, while each one had their own individual system. All these undertakings imposed a massive and

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complex construction legacy upon the Jacaguas' valley (Fig. 15).

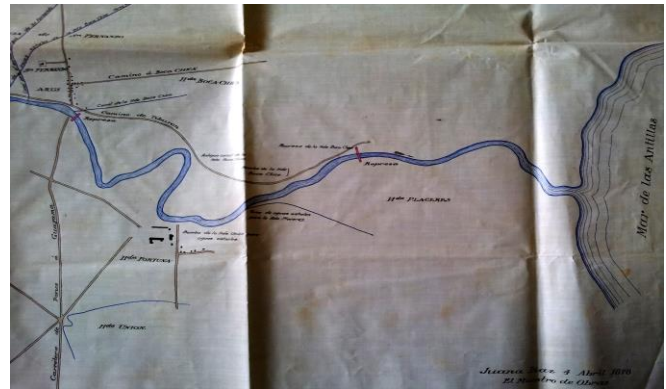
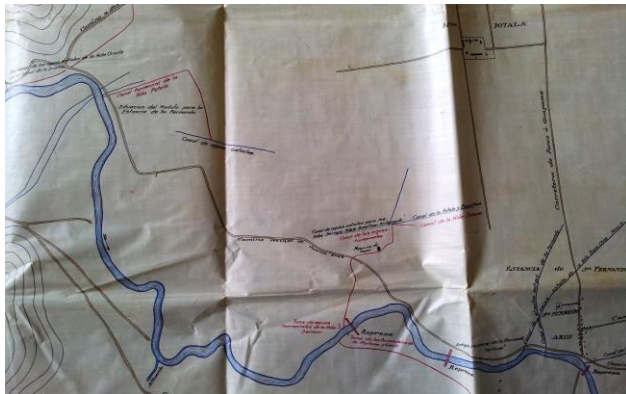
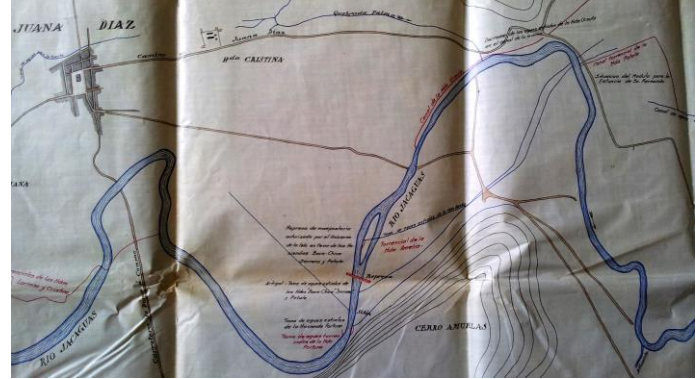
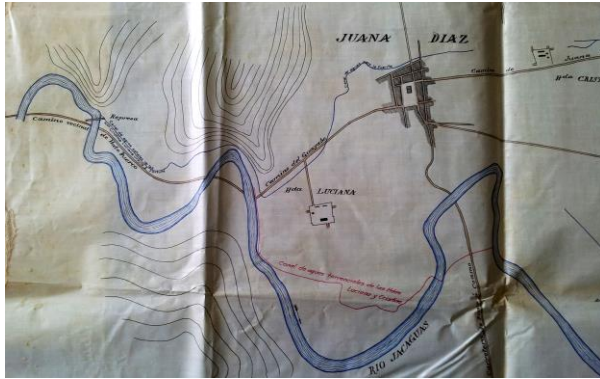


Figure 15. Details of the 1878 plan depicting irrigation systems crisscrossing the Jacaguas' valley.⁸¹

⁸¹ AGPR. Fondo: Obras Públicas. Serie: Aguas. Caja 430. Legajo 73.

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VIII. Water for the people

To be able to open a faucet at the comfort of your home and get the water needed for any insignificant purpose, creates the consumeristic numb illusion of the resource eternal presence or the equally illusory impression that it has always been easy to acquire it. There is a physical and conceptual separation between the modern consumer and the sources of the vital liquid.

The relationship of the 19th century’s population with the water sources was closer, more natural, and intimate, as they were a constant force in determining the organization of the people’s daily material life. The rivers, streams and springs, sustained the basic human needs of drinking, cooking, washing and bathing, and indispensable for animals’ consumption as well. Even with the early settlements developed nearby the water sources, to use it, it was required for the population to physically transport the water in improvised containers to their homes or to actually go out into the source itself (**Fig. 14**).

Concessions granted to municipalities to provide water for their urban populations were not as numerous as those granted for irrigation or hydraulic use. In January 28, 1862, Mayaguez received one of the earliest concessions, been authorized to take 21.11 liters per second from the Yaguez River to supply the city. That very same year, Juana Diaz was granted four liters per second from Jacaguas River for a public fountain. On December 16, 1874, the “*Ilustre Ayuntamiento de Ponce*”, was authorized to draw 23.15 liters from Portugués River. On August 13, 1886, Guayama was granted four liters per second from Guamaní River. On January 15, 1896, Arecibo received the concession of 14 liters per second from the Tanamá River, and Adjuntas, on May 20, 1897, was granted four liters per second from the stream named *Pueblo*, for its urban dwellers.⁸²

⁸² AGPR. Fondo: Obras Públicas. Serie: Aguas. Caja 465. Legajo 190.

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Figure 14. This 19th century photo captured a daily, common scene across the island, showing a group of females washing clothes, while farmers bring their working oxen to drink at the Yaguez River in Mayaguez.⁸³

Some municipalities channelize the nearby water sources into fountains placed in the urban centers, allowing their dwellers to take as much water as needed. This system provided for the formation of a group of urban workers, called *aguaderos*, who made their living delivering water to people’s homes for a fee. Among the urban public water supply, the town of Aguadilla developed one of the most effective and collectively remembered public water fountains using a natural spring named the *Ojo de Agua*. In 1850, a masonry rectangular framing box was built around the spring, encapsulating its fresh waters. The masonry container had six water faucets for public use. In front of the container, one masonry pond was built as a public bathing pool, and a lower container provided water for animal bathing and consumption (**Fig. 15**).

⁸³ William S. Bryan, ed., *Our Island and Their People. As Seen With Camera and Pencil*. N.D. Thompson Publishing Co. Volume 1, 1899.

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Figure 15. The “Ojo de Agua” in Aguadilla. The three statues mark the masonry box built around the spring, which access was blocked by a set of elaborated iron fence. Just below the spring fountain is the public bathing pool, and at a lower level in the foreground is the animal pond. An “aguador” poses at the center of the photo. Water was carried by the “aguadores” to private homes at a rate of ten cents per bucket. To the left, is the 1865 *Puente de la Reina* Bridge.⁸⁴

During the last four decades of 19th century, due to their economic strength, some municipalities were able to provide potable water to their urban dwellers through more elaborated aqueducts systems. According to a 1900 War Department Report, San Juan, Ponce and Mayaguez had river water piped to and distributed in the urban centers; Guayama had a rude system of water supply, and Arecibo had an incomplete installation to provide water for its city dwellers.⁸⁵ An article published in 1924 in the magazine *Revista de Obras Públicas de Puerto Rico*, mentioned seven aqueducts systems operating in the island by 1898. The cities of Mayaguez and Naguabo, built theirs by 1867; Juana Diaz and Guayama, in 1868; Ponce, in 1878; Patillas in 1892, and the capital, San Juan, had its system built in 1895.⁸⁶ However, the 1899 publication *Our Islands and Their People* pictured what seems to be a

⁸⁴ Ibid. Vol. 1, 349.

⁸⁵ Annual Report of the War Department for the Year Ending June 30, 1900. Government Printing Office. Washington, 1900, 201.

⁸⁶ Guillermo Esteves, *Desarrollo de las Obras Públicas de la Isla de Puerto Rico*. *Revista de Obras Públicas de*

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well-developed aqueduct system built in the town of Utuado, not mentioned by either the War Department Report or by Esteves' article (**Fig. 16**).



Figure 16. The aqueduct system in Utuado.⁸⁷

The article in the *Revista de Obras Públicas* mentioned that the aqueducts built at Mayaguez, Ponce and San Juan were the most efficient. San Juan's 1890s aqueduct system was listed in the National Register of Historic Places (NRHP) on June 21, 2007.⁸⁸ The aqueduct stands among the best example of a late 19th century potable water providing waterworks in the island. Most of its components were built between 1892 and 1899, corresponding to the aqueduct's steam power period. The property includes a significant number of extant resources, among them a weir, filtering tanks and the pumping house (**Fig. 17**).

Puerto Rico. Enero de 1924. Año I. Núm I.

⁸⁷ William S. Bryan, ed., *Our Island and Their People*.

⁸⁸ National Register of Historic Places. *Acueducto de San Juan*. June 21, 2007. 07000585. Photos in Figure 17 are from the nomination document.

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Figure 17. Partial view of some of the surviving resources of *Acueducto de San Juan*. With additional resources added during the 20th century, the aqueduct operated until 1980.

A quick look at the two earlier systems sheds some light upon the complexity and accomplishments of the locals and general government during the 19th century in attempting to provide potable water to their urban dwellers.

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The Mayaguez's Aqueduct

The city of Mayaguez was the pioneer in the process of developing an aqueduct system for water provision to a general public. As such, its experience became a learning process for government officials, engineers and contractors, foremen, skilled and unskilled labor, in future projects. People associated to the Mayaguez's aqueduct, like Francisco Valls and Timoteo Lubelza, became familiar names in the design, planning and construction of other public water systems and many private irrigation projects.

By early 1862, according to historian Ramonita Vega Lugo, the Mayaguez's City Council formed a commission to evaluate the aqueduct plans designed by Timoteo Lubelza. On February 2, 1862, the then governor Rafael Echague, placed the first corner stone in a building named *Canal del Principe Alfonso*, which was to be part of the complex, initiating a five years undertaking.⁸⁹ However, necessary actions were taken way before the date provided in Lugo's work. By 1854, Timoteo Lubelza, Inspector of the District Public Works, had already estimated the amount of 37,500 pesos (which failed very short of the final cost) as the money needed for the construction. He also prepared the legal conditions and construction requirements to be followed by whoever was awarded the contract (*pliego de condiciones*).⁹⁰ In January 1860, it was presented to the City Council the first list of expenses incurred in equipment and man-hours as part of the operations conducted to obtain comparative elevations and surveilling in the aqueducts' route.⁹¹ On November 1, 1861, the City's Corregidor, Policarpo Alvarez, and Timoteo Lubelza, conducted an important meeting with the landowners on whose properties the aqueduct's water pipes and deposits were to be placed. With the exception of the proprietor of the place designated to build the water deposit, every other owner surrogated the needed land and the rights of ways to keep proper maintenance of

⁸⁹ Ramonita Vega Lugo, *Urbanismo y Sociedad. Mayaguez de Villa a Ciudad, 1836 – 1877*. Academia Puertorriqueña de la Historia. San Juan, 2009, 340-341.

⁹⁰ Archivo Histórico Municipal de Mayaguez (AHMM). Documentos Históricos Encuadernados. Vol. 3. Legajo 31. Proyecto de acueducto y fuentes para Mayaguez. Legajo 37, Pliego de Condiciones.

⁹¹ AHMM. Ibid. Legajo 83. Relación de las cantidades invertidas hasta la fecha en jornales y demás en la nivelación hecha para el acueducto de esta villa.

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the future aqueduct, without requesting any compensation.⁹² The aqueduct's contribution to the general population's well-being was clearly understood.

In 1862, after Lubelza's plan approval, and the official initiation with the Governor presence, the city embarked on a five year undertaking that tested the town's resilience. The actual undertaking was divided in two parts: all the works in masonry and carpentry, and another part consisting of everything related to water piping for the planned ornamental fountains at the town's plazas, residential and commercial water tubing, and the public water spouts. The first part was almost completed by August 1865. But it wasn't until June 1864, after many failed auctions, that the second part of the planned works was granted to the firm *Sociedad Gutierrez y Lloreda*. By October 1864, the contractors dispatched their representative, Lorenzo Carbó, to Europe with diagrams and drawings of pipes and especially designed tubes, to locate the right foundry for the job. Carbó traveled from Belgium, to France, to England, finding in Glasgow the company able to do the required work. Unfortunately, some months later, a general strike by coal miners in England put a stop to many foundries. Due to these problems, by June 1865, Gutierrez y Lloreda, requested a year extension to complete the works.

Hard financial times complicated the situation even more. In the 1863 budget report, the municipal officials mentioned that 23,303 pesos had already been used for the aqueduct's works.⁹³ By July 1865, Pedro A. Bisbal, engineer and director of the works, indicated that 51,388 pesos were needed to complete the project. With only 26,598 at hand the City Council requested from the general government authorization to get a loan from private investors to complete the expensive works. On November 16, 1865, the central government authorized the city to get the loan. That very same year, to ease the city's financial hardship, Governor Echague approved a decree indicating that construction equipment and material for the aqueduct brought from abroad was tax exempted.

⁹² Ibid. Legajo 258.

⁹³ Ibid. Documentos Históricos Encuadernados, vol. 2. Depositaria de los fondos municipales de Mayaguez.

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It was precisely in July 1865, when the shipment from Glasgow arrived at the Mayaguez's port, bringing all equipment needed for the piping system. The ship (*bergantín goleta*) "*Fearless*" brought 3,204 cast iron pipes, seven boxes of pipes fittings, forty-two cast iron nozzles, forty-five different types of valves, 42 cast-iron fire hydrants, among other things.⁹⁴

By June 1866, the project was completed. The final payments made on the loans, showed a total of 96,163 pesos invested in the aqueduct. During the initial months, although the new system was view as a great accomplishment, it was not widely received as the tariffs for water conduction to the private residences was set at a high rate. Eventually, lower prices were applied to make it rentable. When Manuel Ubeda y Delgado reported about Mayaguez in his 1878 work, it was mentioned that the city had four ornamental water fountains: one at the main square, one at the Catholic Church's square, one at the Market Square and one in front of the Custom House, near the port area. Ubeda reported also nineteen public sprouts for the general population and four hundred private residences in the urban center with water faucets connected to the aqueduct pipes. The fees charged to these four hundred customers, represented an annual income of 4,000 pesos to the municipal treasury.⁹⁵ Still, with 1,112 households in the urban center at the time, water at private residences remained a privilege of the few. However, the system provided for fire hydrants strategically located throughout the town, and public sprouts that were extremely beneficial for the general population health, safety and comfort.

⁹⁴ Ibid. Legajo 2182. Declaración de la Real Aduana.

⁹⁵ Manuel Ubeda y Delgado. *Isla de Puerto Rico. Estudio histórico, geográfico y estadístico de la misma*. Puerto Rico. Establecimiento tip. del Boletín, 1878, 195-202.

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The 1888 “*Plano de la Ciudad de Mayaguez*”, done by Federico Drouyn, allows to locate the aqueduct’s main distribution center and two of its deposits (**Fig. 17**)

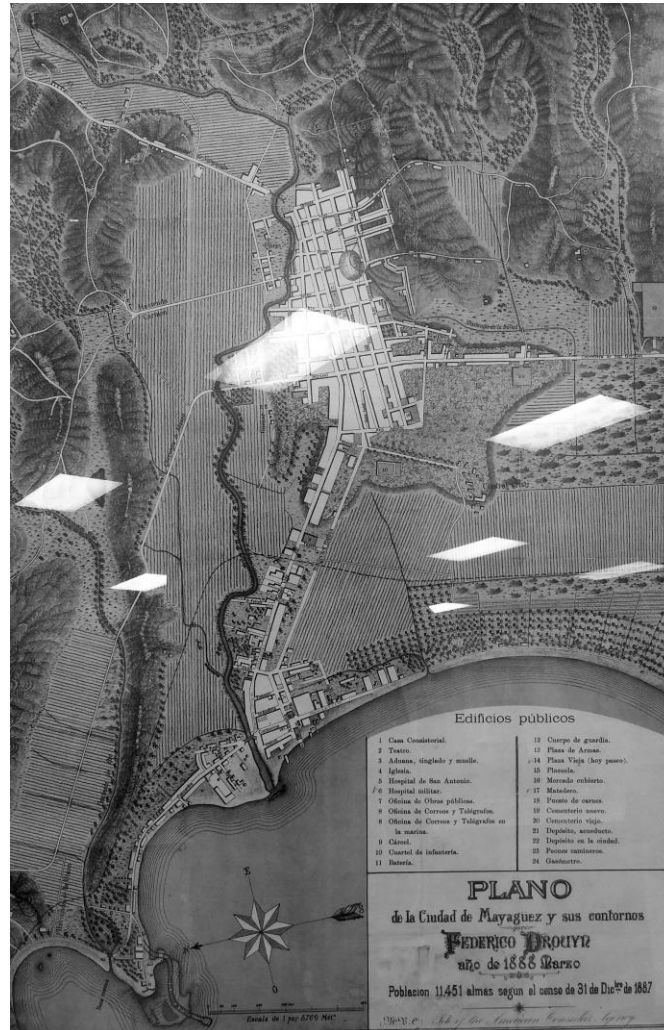


Figure 17. Site #21, on the outskirts northeast section of town, was the aqueduct’s main deposit. Another one was located on the western end of town, in Calle Mendez Vigo, towards the port area (Site 22). The main deposit’s site belongs today to the *Autoridad de Acueductos y Alcantarillados*.⁹⁶

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The Alfonso XII Aqueduct in Ponce

By the 1870's, Ponce had become the economic, cultural and social capital of the southern region. Just a small settlement consisting of 115 houses and 5,038 souls scattered around a small plaza with a little deteriorated church in the center by the late 18th century,⁹⁷ by 1876, excluding public buildings and hatch huts, the urban core consisted of nine hundred and seventy-three residences: 53 two-story brick and masonry houses; 101 houses one story houses of the same material; 33 two-story houses of mixed construction (masonry at the lower level with a wooden upper floor); 37 two-story wooden houses and 741 one-story wooden houses.⁹⁸ By 1878, Ponce's was a striving city with four (4) squares, an urban grid with thirty-four (34) major streets, one thousand and eighty-four (1,084) houses, two hundred and sixty (260) huts and two thousand two hundred and four (2,204) families co-existing within the urban core.⁹⁹

Ponce's urban development reflected its economic success. During the first decades of the 19th century, as Puerto Rico's foreign trade became significant, so did cities with port facilities. Ponce took advantage of its location and its adequate port, to channelize not only its production, but also that of the adjacent municipalities. By 1890, Ponce exported 33.2 percent of the island production, while San Juan accounted for 21.2 percent.¹⁰⁰ Ponce's production and commerce gravitated around two main crops: sugar and coffee. The sugar industry brought its collateral consequence: the establishment of a social framework based on slavery. In Ponce, more than in any other region of the island, sugar and slavery became synonymous. The slave commerce, the slave-based sugar industry, the coffee and other crops produced in the southern and surrounding regions and exported from Ponce, sustained the creation of a strong commercial and landlord class, formed by immigrants, Peninsular and creoles groups. These upper groups eventually formed an urban bourgeoisie that shaped Ponce's urban

⁹⁶ AHMM. Plano de la Ciudad de Mayaguez y sus contornos, marzo de 1888. Federico Drouyn. Not in catalog.

⁹⁷ Iñigo Abbad y Lasierra, *Historia geográfica*, 326.

⁹⁸ Ramón Marín. *La Villa de Ponce considerada en tres distintas épocas, Estudio histórico, descriptivo y estadístico, hasta finales del año 1876*. Establecimiento tip. "El Vapor", 1877, 346.

⁹⁹ Manuel Ubeda y Delgado, *Isla de Puerto Rico. Estudio histórico*, 219-222.

¹⁰⁰ AGPR. Gobierno de Puerto Rico. Estadística general del comercio exterior y balances mercantiles. 1895.

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landscape. The commercial activity in the city attracted into the urban core the wealthy merchants and the *hacendados*. It also attracted carpenters, artisans, brick layers, contractors, architects, engineers, artists and many others as well. It was, however, the wealthy-classes, the patrician families, the ones that imposed their manorial worldview upon the city’s urban cultural character and built landscape (**Fig 18**)



Figure 18. Two examples of the 19th century residential type buildings associated with Ponce’s wealthy merchants and landlords. Left, *Casa Vives*, built in 1860 for the landlord and slaver Carlos Vives, owner of the well-known *Hacienda Buena Vista*. Right, *Residencia Armstrong Toro*, constructed in 1899 for Carlos Armstrong, a city merchant strongly associated with the international exports and the local slave commerce.¹⁰¹

In such embellished city, a system to provide potable water for its dignified dwellers became a needed requirement. Fortunately, the money to initiate the project was provided by the good deed of Valentín Tricoche. When the Spanish landlord Tricoche died in August 1863, he left to the city an endowment in his will of 82,970 pesos to build a charitable shelter for the poor and an aqueduct. The *Albergue Caritativo Tricoche* was finished in 1875. By that time, 53,717 pesos were left for the aqueduct project.¹⁰² Tricoche saw the aqueduct as an investment and his plan was that the money obtained from the sale of water to city residents and local business and industry could be used for the maintenance of the hospital. In 1878, when Ubeda y Delgado reported about Ponce, he mentioned that the project had already

¹⁰¹ *Casa Vives* was included in the National Register of Historic Places on February 13, 2013. *Residencia Armstrong* was included on October 29, 1987. (Juan Llanes Santos, photographer).

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started, but it wasn't finished. The final cost was estimated as to be 128,000 pesos and it was to include ornamental water fountains, fire hydrants, public sprouts, and connections to private residences.

On February 14, 1875, after been proudly announced by several means by the city officials and inviting all the *Ponceños* to participate in the ceremony, Governor José Laureano Sanz, symbolically placed the first cornerstone of the future water deposit at the foot of the mountain historically known as *El Vigía*, northwest of the urban center (**Fig. 19**).

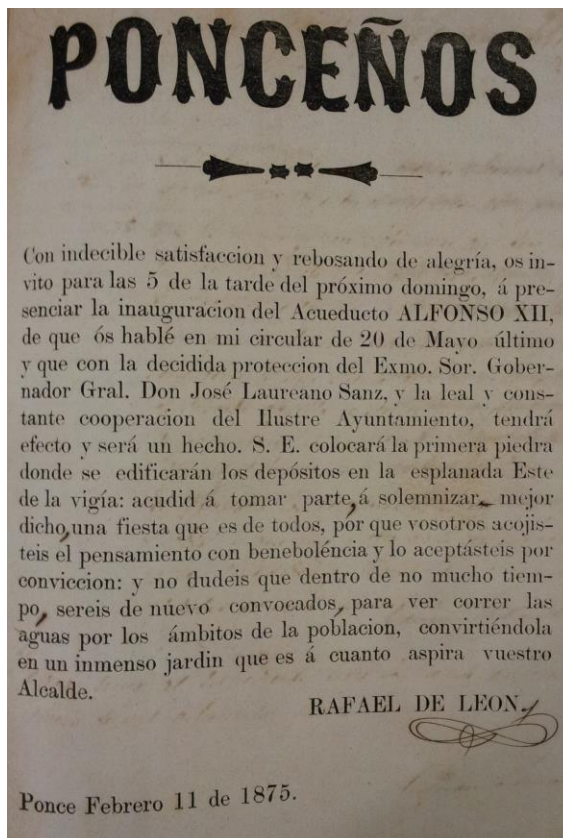


Figure 19. City Hall announcement for the Alfonso XII Aqueduct ceremony.

¹⁰² Manuel Ubeda y Delgado, *Isla de Puerto Rico. Estudio histórico*, 217

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However, the actual work didn't started until August 1876. In between the official ceremony and the beginning of the actual construction, the required studies, the logistic and the planning was organized. Once again, Timoteo Lubelza, main planner of the Mayaguez's aqueduct, was in charge of the design and the *Pliego de Condiciones*, the detailed instructions of the construction process.

A small dam, just one meter high, was built across the Portugués River to deviate the waters into a masonry canal. The canal was 3,730 meters-long, from the water intake until the water deposit. Throughout most of its length, the masonry canal was underground, consisting of a vaulted brick and masonry tunnel 0.60 meters wide and 0.90 meter in height. Not far from the intake at the river, the water passed a filtering process which consisted of running it through three different layers: one of loose sand, then one of thin gravel and the last one made of grinded stones. Every two hundred and fifty meters along the underground canal route, a *registro* (manhole) was built to allow for its proper cleaning and water monitoring.

Because of the route's topographical conditions, at some instances the canal came above ground, becoming a visible structure. This was particularly true in the section where the canal crossed "*la quebrada de Canterá*". It was planned by Lubelza, that at points of significant drop-off, ground depressions, and other natural or man-made obstacles, brick and masonry *murallones* were to be used to overpass those. As planned, the *murallones* would it have two arcs, to allow for the proper flow of the downpour waters underneath the structure. However, as mentioned in Lubelza's plan, the *murallón* over "*la quebrada de Canterá*", had to have three arcs, to allow not only the rainwaters flow, but also to not interrupt the neighboring road already in use at the location (**Fig. 20**)

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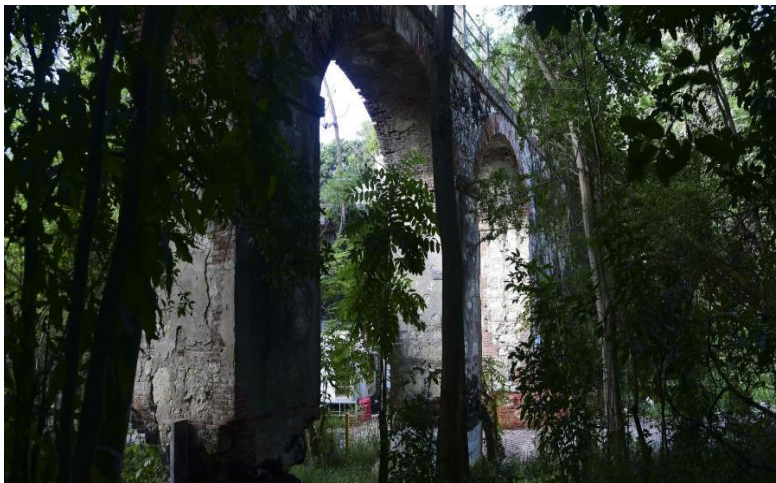
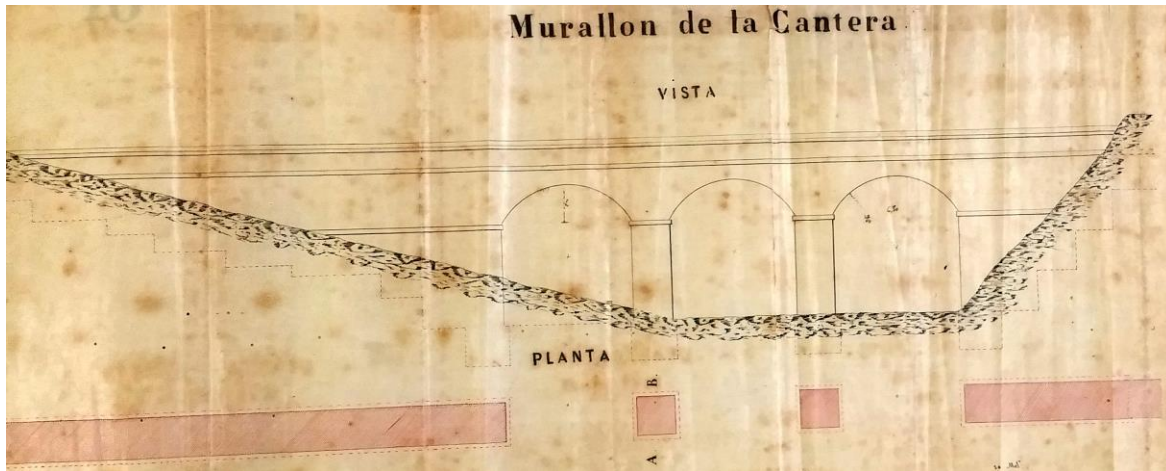


Figure 20. Above, the 1875 Lubelza's plan for the *Murallón de la Cantera*. Below, a partial view of the extant resource. The water ran in the canal atop, while the elevated arcs allow the downpour flow and folks transit. From its top, the structure is about fifty-feet high. (Juan Llanes Santos, photographer)

With a 0.0005 meters-gradient, the water moved through the entire canal by simple gravity, finally reaching the water deposit located at the north end of Atocha Street, in the town outskirts. The deposit, built completely underground, was a brick and masonry two thousand cubic meters capacity rectangle tank, twenty-five meters long and twenty-four meters wide, divided by a two meters wide brick and masonry wall in two equal chambers. Each one of the chambers had a barrel vault ceiling, supported by a central arcade. The vaulted ceiling started four meters from the ground-bottom, been four meters precisely the height of the water level at

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both chambers in the deposit. From the deposit, the water was distributed throughout the city by a network of cast iron pipes. The main pipe, 0.35 meters in diameter, ran from the deposit straight down *Atocha*, the town main artery, towards Marina Street, at the southern end of the city. From the main pipe, transversal pipes ranging from 0.15 to 0.25 meters in diameter, distributed the water along the urban center (**Fig. 21**).

On May 18, 1878, the gate at the Portugués dam was lifted to allow the water into the distribution canal. It took forty-five minutes for the water to reach the city. On November 1878, the city officials properly accepted from the contractors the entire water work. The aqueduct system provided twelve public sprouts conveniently located for public use. A large number of fire hydrants (*bocas de riego*) were also strategically placed around the city. Two washing places were built, one in the high grounds in the urban ward of Cantera, and another in Calle Isabel. The washing places had a capacity for one hundred laundress each. One drinking trough for the city’s animals was built nearby the washing place in Calle Isabel. Additionally, the new aqueduct provided the water for two ornamental fountains placed at the city’s *Plaza Principal* (north across city hall) and one for *Plaza de las Delicias*, the second mayor town square. Of course, modernity came through those iron cast pipes, as water was now available for those individuals and business willing to pay the annual fee for their private services.¹⁰³

¹⁰³ Archivo Histórico Municipal de Ponce (AHMP). Fondo: Ayuntamiento. Sección: Secretaria. Subsección: Obras Públicas. Serie: Acueductos y Alcantarillados. Cajas S-369/ S-370. This archival reference contains the primary documents used for the Alfonso XII Aqueduct’s narrative in the section above.

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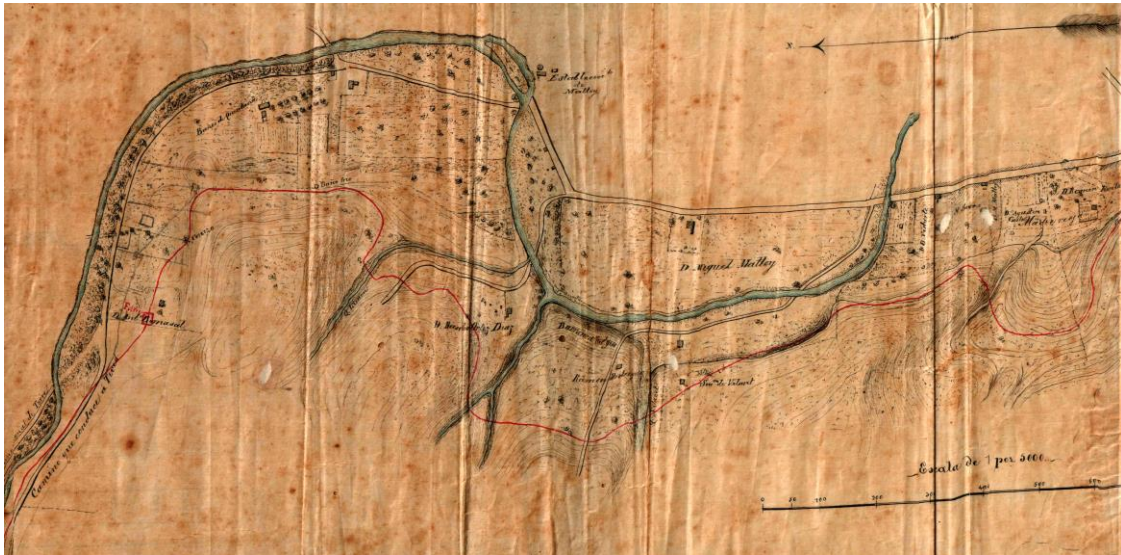


Figure 21. The upper image of the 1875 map prepared by Timoteo Lubelza shows the canal's route (in red) from the intake in the Portugués River, along Ponce's north outskirts, towards the deposit. The image below depicts the aqueduct's pipe network from the deposit throughout the city (also in red)

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IX. Conclusion

The 19th century sugar and coffee boom in Puerto Rico placed a great demand upon the water sources. Beginning in the 1840s, water concessions were frequently granted by the general government to sugar barons, large coffee producers and owners of large haciendas producing minor crops. Additional pressure upon the water sources was added as some municipalities successfully developed systems to provide potable water to their urban dwellers. Accessing and controlling the water sources became a matter of economic survival, class struggle and competition among a wide range of individuals and institutions in the social spectrum.

Depending on how the water was to be used, three property types could be identified: irrigation systems, water power hydraulic systems and potable water systems. Each one of this systems had their particular components. However, every concession meant an undertaking that normally involved the construction of river dams, water modules and distribution canals. The historic documentation sustains that mostly, solid materials (stone, brick and masonry) were used as means of construction, allowing for the very likely possibility that many of these resources endure the test of time. The large number of concessions granted also help to increase the resources' survival potential.

Thousands of meters of solid stone, brick and masonry canals crisscrossed Puerto Rico's southern, southeast and southwest valleys for agricultural purposes. Many more were built to provide water for mechanical or human use. Tens of cubic feet of historic documentation is available showing how and where many of these undertakings took place. Both, the extant resources and the documents, are just waiting for the researchers to put them together and bring them back into the collective memory.

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F- Associated Property Types

The property types defined in this Multiple Property Submission cover document are the product of a preliminary reconnaissance survey that identified different individual properties which associative attributes tied them to the historic context presented in this cover document. All these properties derive significance from their association with a pattern of historic events, namely, the importance of the 19th century water works (irrigation systems, aqueducts systems and hydraulic force systems) to the economic and social development of Puerto Rico. These properties also embody the distinctive characteristic of a type, period and method of construction, conceived and practice in Puerto Rico by 19th century’s architects, engineers and craftsmen. As such, Criterion A and C are the principal National Register Criterion applied in this Multiple Property Submission cover document.

The preliminary survey was intended to identify those properties capable of transmit the associative attributes of the historic context developed in this cover document. The survey was not conducted to meet the Secretary of the Interior’s Standards. This survey verified the existence and location of properties with interpretative potential. A nomination of an individual property is submitted with this cover document: *Sistema de Riego de las Tres Haciendas*, property located in the municipality of Santa Isabel. This selection does not preclude the registration of other properties identified in future efforts.

This Multiple Property Submission is organized in one general context, *Waterworks in Puerto Rico, 1840-1898*, subdivided in seven sections: *Becoming a Sugar Island*; *Coffee: the Gold from the Highlands*; *Accessing the Water Sources*; *Regulating the Water Sources*; *Water Rights as a Source of Power and Struggle*; *Looking at Some of the Waterworks* and *Water for the People*, with an *Introduction* and a *Conclusion*. Three major property types were identified as a reflection of the historic pattern of events detailed in the developed context: the irrigation systems, the water power hydraulic systems and potable water systems (aqueducts). Future efforts can develop other property types underrepresented in this cover document.

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I. Name of Property Type: Irrigation System

Description

Irrigation is the method in which water is supplied to plants at regular intervals for agriculture. It is used to assist in the growing process of agricultural crops, maintenance and revegetation of disturbed soils in dry areas and during periods of inadequate rainfall. In Puerto Rico, during the 19th century, numerous irrigation systems were built by private landlords to supply water for their sugar and coffee haciendas, mostly in the southern region of the island. These irrigations systems were not determined by aesthetical approaches or trends, but by functionality.

The typical irrigation system had three main component: the river dam, the water module or water intake and the canal distribution system. Each one of these component, as described in the historic context of this cover document, is a character defining feature on itself. Three methods of construction were mostly used for the river dams: a solid construction of masonry and stones; the use of tightly-pack-loose rocks; and in some instances, the use of wooden planks. The first method has the best possibility to endure time. The water modules, as described in this cover document, were located at the water intake, consisting of an initial bricks and masonry canal, usually 0.40 to 0.60 meters wide, with masonry walls of 0.60 to 1.0 meters high. An iron grill was normally found bolted down at the initial section of the module. Few meters past the iron grill to capture debris, a manually operated iron gate to control the water flow was also normally found in the water module. The distribution canal, which lengths varied according to the distance between the water source and the irrigated fields, had two dominant constructing variations: ground levels masonry open canals and underground vaulted brick and masonry canals; both usually with a tamped-down pebbles (*chinos de río*), or hydraulic mortar flooring. The presence of the mentioned construction materials like brick, masonry, stones, *chinos de río*, wood and cast iron, it's also a character defining feature of the property.

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II. Name of Property Type: Water Power Hydraulic System

Description

In a water power system, the water is used as an engine to generate movement upon a mechanical stationary object for production purposes. In Puerto Rico, during the 19th century, numerous water power systems were designed and built by private owners to use water as a hydraulic force to move agricultural equipment in sugar estates, coffee haciendas and other types of farms. These water power systems were not determined by aesthetical approaches or trends, but by mechanical functionality.

The typical water power system in the island had five main components: the river dam, the water intake or water module, the distribution canal, the stationary mechanical equipment and the drainage canal. Each one of these components, as described in the context of this cover document, is a character defining feature on itself. Just like in the irrigation systems, in the water power system the river’s current was diverted by the use of a dam into the water intake or water module. The distribution canal transported the water to the estate’s factory either to move a wooden or iron wheel. These wheels transmitted the moving force to mechanical equipment in order to either squeeze the sugarcane, grind corn or clean the coffee seeds. Once the water was used, it was returned to its source (river) by a drainage canal.

Three of the five main components of a water power system (the river dam, the water intake or water module and the distribution canal) have been properly described in the section above (Irrigation Systems). The drainage canal, according to the 19th century water laws, was a required element when the water was to be used as a hydraulic force, so it can be properly return it to its natural course (riverbed). Almost every historic document related to this type of water work, shows that the drainage canal was usually an open trench cut in the natural ground, hardly able, although not impossible, to endure time. The other component, the mechanical component at the factory, was usually a wooden or iron gravity-driven wheel or an impulse-driven wheel. Both water-powered wheels were use in sugar estates, coffee farms, and minor fruits farms. However, the gravity-driven wheel, the most energy efficient of both

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types, was an overshot and high-breast wheel, found among the most advanced sugarcane estates in Puerto Rico in the 19th century used to move the sugarcane crushing mill's mechanism. It was also frequently found among the coffee haciendas whose product was to be sold in the international market.

III. Name of Property Type: Potable Water Systems (Aqueducts)

Description

The Potable Water System is the process of conduit or artificial channel for conducting water from a distance, usually by means of gravity. The term aqueduct also applies to the bridge-like structure that carries a water conduit or canal across a valley, a depression, or over a river. During the 19th century, several cities in the island developed more or less complex projects in order to provide portable water for their urban dwellers. Mayaguez, Ponce and San Juan, developed the most efficient water providing systems.

The aqueducts projects had several main components: the river dam, the water intake or water module, the water distribution canals, the filtering stations, aqueducts structures (when needed), the water deposits, and finally, the water piping distribution system. Each one of these components, as described in the context of this cover document, is a character defining feature on itself. Once the systems became operable, a whole complex of built resources like ornamental water fountains, public faucets, fire hydrants, washing places, public baths and drinking troughs, would appeared within the urban landscape associated and as dependent appendixes of the potable water system.

IV. Significance

The properties associated with this Multiple Property Submission cover document (forming this property types) are eligible for listing in the National Register of Historic Places under Criterion A in the area of Social History for their association with patterns of events that have been statewide significant as they convey the social efforts to promote the welfare of

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society, along with the history, the lifeways and material organization in a particular period and time of the social groups to which the resources are associated. The resources, particularly the irrigation and water power systems, are significant also under Criterion A in the area of Agriculture, as they convey the process and technology of soil cultivation and crop producing used in Puerto Rico during the 19th century. The properties are also eligible for listing under Criterion C in the area of Engineering as they represent the distinctive characteristics of a particular period and method construction. The property types identified (irrigation systems, water power systems and potable water systems) show the practical application of engineering principles to design and construct structures directed to serve human needs.

V. Registration Requirement

Urban development and expansion at the expense of the 19th century traditional agricultural fields is an unavoidable fact. Combined with mistreatment by the surrounding communities and abandonment by the previous owners, an adverse effect upon 19th century water works extant resources is expected, and it should be taken in consideration when evaluating the resources' integrity. The finding of a system (irrigation, water power or potable water system) with its complete, intact components (as described in this cover document) is highly unlikely. As such, individual components could and should be evaluated for inclusion into the National Register.

In order to qualify for listing, the resource must have been a character defining component as part of an Irrigation system, a Water Power System or a Potable Water System, as identified and described in this cover document. Except where specified, eligible resources must have integrity of location, design, setting and materials. Those resources eligible under Criterion A should be able to convey their association to local or statewide historic events as they represent the interests, lifeways and worldview of the involved social groups. They could also be eligible under Criterion A as the resources might be associated to a local or statewide significant sugar or coffee 19th century haciendas. They are also eligible under Criterion A if

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the resources retain their ability to convey the process and technology of soil cultivation and crop production during the 19th century.

Those properties eligible under Criterion C should be considered even if alterations to form and materials exist, so long as the significant engineering design is prominent and discernible. In a Potable Water System, for example, a character defining feature like an elevated aqueduct, could be considered eligible if it retains location, design, and enough fabric materials to yield relevant information to its historic use or engineering. In any of the three property types identified in this cover document, for example, enough stones and masonry of a dam must stand to represent the original function of the feature. A portion of a canal must retain the visual appearance of an earthen construction, or a vaulted section must be long enough to yield information on its historic function and/or it's engineering. Canal resources must also retain original materials and configuration.

G. Geographical Data

The Commonwealth of Puerto Rico

H. Summary of Identification and Evaluation Methods

The information included in this Multiple Property Documentation Form was taken from primary and secondary sources. Primary sources, which provided most of the information related to this cover document, were mostly consulted at the Puerto Rico General Archives. In addition, some secondary sources were reviewed: history books and partial investigations on the subject.

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